M.TECH.THESIS ABSTRACT 2015

Signal processing, Communication & Networks

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RF Microwaves & Photonics

Power &Control

Title	***:***	***Video stabilization and object tracking using AFFINE-Spatio temporal regularity flow***
Author(s)	***:***	***MD Afaque Azam***
Roll No	***:***	***12104041***
Supervisor(s)	***:***	***Gupta Sumana***

Abstract:

Today, hand held devices are present everywhere. Every mobile phone today comes with an inbuilt camera. This has led to a sharp increase in the amount of videos created by nonprofessional users. The jitters caused by this unintentional motion of the video cameras is very common . Such videos are not only used by common users but also by scientists. Launch pads have a large number of cameras that record footage of space vehicles and the surrounding areas during launches. While they take off, a very large vibration is produced due to thrust. This causes nearby cameras to shake. Aside from making the footage difficult to watch, the instabilities in the background make it hard for viewers to notice any debris that may have fallen from the vehicle, or any other foreign objects. Because of these and many other reasons, video enhancement has become very important. A particular requirement is to stabilize the video. The process of electronically removing this unwanted jitters from the video is called video stabilization. A new model called Spatio-Temporal Regularity Feature(SPREF) is introduced. This feature finds the direction in which sum of directional gradients of pixel is minimum. In other words it gives the direction along which intensity variation of pixel is minimum. Translated box splines are used to approximate the flow curves. We model the video using Affine SPREF and get the regularity direction of each pixel. Using this model we find the global motion of the frames and hence the motion of camera. We perform Kalman filtering to remove unwanted jerks from the intentional motion. Finally we perform image warping to get back stabilized frames in the final stage of video stabilization. We present our result on several test videos. Also a comparison of some standard methods is done using ITF parameter which is explained in the same section. We extend the application of Affine SPREF to object tracking. Object tracking finds several real world applications like Automated video surveillance, Robot vision, Traffic monitoring, Animation etc. We perform foreground segmentation by thresholding the SPREF energy of voxels, of the octree segmented video cubes. The resulting segmented videos are used to keep track of desired moving objects.

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Title	:	*Modeling Twitter Hashtag Trends*
Author(s)	:	*BANSAL SAURABH*
Roll No	:	*Y9227524*
Supervisor(s)	:	*Jagannatham Aditya K*

Abstract:

Microblog (e.g. Twitter) data is an established social medium for information di usion. Patterns of information di usion through such platforms are limited. This thesis presents a method to model such patterns of information di usion using temporal aspects only. We have used the Infochimps dataset which contains the time series for a 5% sample of all tweets between Jan 2008 to Dec 2009. Our analysis unveils that a hash tag's popularity is driven by a combination of lagged time series of the hash tag and the general behavior of the micro blogsphere. Based on this observation we analyze the contribution of di erent variables on popularity and describe a predictive modeling technique for the same using forward step by step ordinary least squares regression. Our analysis shows that the popularity is majorly driven by lagged time series(explains 60% of the variance).

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Title	***:***	***A Distributed Message Dissemination Framework for Emergency Response Systems over Smartphones***
Author(s)	***:***	***Bhatnagar Abhiroop***
Roll No	***:***	***10327015***
Supervisor(s)	***:***	***Sharma Govind***

Abstract:

In this thesis, we propose a framework for distributed dissemination of messages by leveraging the capabilities of smartphones. The major contribution of this work is an implementation of a broker-based peer to peer protocol for prioritized delivery of messages in order to support a fast emergency alert and response mechanism. The fundamental challenge lies in adapting the community inspired publish subscribe model in privacy preserving and scalable manner for high mobility scenarios. Our approach is based on mechanism of dissemination of messages through streaming channels such as Google Cloud Messaging. As social media generated interactions are uncontrolled, they cannot connect directly with an emergency alert and response mechanism. So, we have implemented a distributed device information repository for controlled dissemination of messages along with a framework for handling re- sponses appropriate to alert messages. The two key features we tried to preserve in implementation of our protocol are (i) energy awareness, and (ii) prioritized de- livery of messages. In particular, in this thesis report our focus is on the origin and theoretical rationale of system design and the implementation of the Data Cart Tracker.

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Title	***:***	***Learning Distributed Document Representations for Multi-Label Document Categorization***
Author(s)	***:***	***Gupta Nitish***
Roll No	***:***	***10327461***
Supervisor(s)	***:***	***Hegde Rajesh Mahanand***

Abstract:

Multi-label Document Categorization, the task of automatically assigning a text document into one or more categories has various real-world applications such as categorizing news articles, tagging Web pages, maintaining medical patient records and organizing digital libraries among many others. Statistical Machine Learning approaches to document categorization have focused on multi-label learning algorithms such as Support Vector Machines, k-Nearest Neighbors, Logistic Regression, Neural Networks, Naive Bayes, Generative Probabilistic Models etc. while the input to such algorithms i.e. the vector representation for documents has traditionally been used as the bag-of-words model. Though the usage of simple bag-of-words representation gives surprisingly accurate results, it suffers from sparsity, high-dimensionality, lack of similarity measures along with other drawbacks such as the inability to encode word ordering and contextual information in which the words occur. Encoding contextual information about words in documents is crucial to capture the correct semantic content of the highly complex and ambiguous human language. Our work is focused on learning continuous distributed vector representations for documents by embedding all the documents in the same low-dimensional space such that documents that are similar in their semantic content have similar vector representations. To tackle the issues in bag-of-words representation model, we present an unsupervised neural network model that uses the document vector to predict words in the document along with using the contextual information in which the word occurs and jointly learns distributed document and word representations. We develop a modified version of the logistic regression algorithm to learn similar distributed representations for categories to perform the document categorization task. We show that our model gives state-of-the-art results on the standard Reuters-21578 dataset, improving the bag-of-words model by 9% and previous state-of-the-art by 3.26% in terms of the F1 Score. We also show the effectiveness of our model in imputing missing categories on the Wikipedia articles against the bag-of-words representations. As we embed documents, categories and words in the same low-dimensional space our model can also estimate semantic similarities between them. We qualitatively demonstrate that the learned representations capture the semantic dependencies between categories and words which is not directly observed in the data.

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Title	***:***	***HDR imaging with conventional cameras***
Author(s)	***:***	***Nawhal Megha***
Roll No	***:***	***10327397***
Supervisor(s)	***:***	***Venkatesh K S***

Abstract:

Real world scenes have huge intensity variations which are not in the control of the capture process. While the human eye has an excellent dynamic range that enables us to visualize precise contrast variations, and dynamically adapts to illumination variations, the dynamic range of the conventional imaging devices is limited because of the physical constraints of the sensors. Image saturation is observed often when lighting conditions are very bright. In such scenarios, the captured image will have some optimally illuminated parts while some parts may undergo saturation (underexposure or overexposure). This is due to the gray level clipping of the camera sensor. The consequence of this clipping is complete loss of detail in the saturated regions, which makes the image aesthetically unappealing for human use as well as unsuitable for machine consumption, because of the disappearance of all feature information. In this work, we propose a solution to recover the scene information lost due to saturation, and hence produce a better quality image. This final output high dynamic range(HDR) image is obtained by blending a sequence of gain-shifted low dynamic range (LDR) images. We also put forth an idea of solving the problem of image saturation during the acquisition process at pixel level to achieve resultant image with no or minimal saturation.

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Title	***:***	***People counting in high density crowds from still images***
Author(s)	***:***	***Bansal Ankan***
Roll No	***:***	***10327095***
Supervisor(s)	***:***	***Venkatesh K S***

Abstract:

In this work, we present a method for estimating the number of people in high density crowds from still images. The method estimates counts by fusing information from multiple sources. Most of the existing work deals with very small crowds (tens of individuals) and uses temporal information from videos to estimate the counts. Our method uses only still images to estimate the counts in high density images (hundreds to thousands of individuals). At this scale, several problems including occlusion, perspective, few pixels per person and clutter render counting by human detection infeasible. Also, we cannot rely on only one set of features for count estimation. We, therefore, use multiple sources, viz. interest points (SIFT), Fourier analysis, wavelet decomposition, GLCM features and low confidence head detections, to estimate the counts. Each of these sources gives a separate estimate of the count along with confidences and other statistical measures which are then combined to obtain the final estimate. We tested our method on an existing dataset of fifty images containing over 64000 individuals. Further, we added another fifty annotated images of crowds and tested on the extended dataset of hundred images containing over 87000 individuals. The counts per image range from 81 to 4633. We report the performance in terms of mean absolute error, which is a measure of accuracy of the method, and mean normalised absolute error, which is a measure of the robustness.

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Title	***:***	***Flash crowd handling in P2P live video streaming systems***
Author(s)	***:***	***Dwivedi Anurag***
Roll No	***:***	***10327132***
Supervisor(s)	***:***	***Singh Yatindra Nath***

Abstract:

Peer-to-peer systems have greatly enhanced live streaming experience by creating efficient and highly scalable streaming overlays where bandwidth capabilities of all peers can be utilized. However, realization of such systems have been challenged by the phenomenon of flash crowd - the arrival of hundreds of thousands of peers in a very short span of time. Such situations may typically arise at the beginning of live streaming events such as a football match or a live lecture. Experiments have shown that the system can scale only up to a limit during flash crowd. This is limited both by the available surplus bandwidth as well as the intense competition among the peers for scarce initial resources. Various population control measures have been suggested for both mesh-based and tree-based live streaming systems. The main focus area of this thesis is on tree-based systems. Such systems have seen some centralized solutions. In this thesis, a distributed algorithm with minimal central control is presented which organizes the newly arrived peers into hierarchical positions to reduce competition among them. This hierarchical rank is then used to construct different sub-stream trees. The video stream is divided into sub-streams and each sub-stream is pushed over a separate sub-stream tree. Only the peers at the top of the hierarchy will directly access the scares initial resources and in turn forward the stream to those below them in the hierarchy. Thus, by utilizing the resources provided by the newly arrived peers in handling ash crowd, better system scale can be achieved.

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Title	***:***	***SBL based joint sparse channel estimation and maximum likelihood sequence detection in OSTBC MIMO-OFDM systems***
Author(s)	***:***	***N S Yashaswini***
Roll No	***:***	***13104161***
Supervisor(s)	***:***	***Jagannatham Aditya K***

Abstract:

In this work, we begin with sparse representation of the wireless multipath channel in an orthogonal space-time block coded (OSTBC) multiple-input multiple-output (MIMO) orthogonal frequency division multiplexing (OFDM) system owing to the fact that the number of active components in the multipath power delay channel profile are very less in comparison to the overall delay spread. Based on this, we additionally consider a challenging ill-posed channel estimation scenario in which we exploit the inherent temporal sparsity and employ the sparse Bayesian learning (SBL) framework to develop a robust pilot-based channel es- timation scheme. Furthermore, we also propose a novel data aided SBL-based joint sparse channel estimation and maximum likelihood sequence detection (MLSD) technique based on the expectation maximization (EM) framework and illustrate that the seemingly intractable joint estimation paradigm finally reduces to an SBL-based sparse channel estimate in the E-step followed by a novel modified ML decision metric-based sequence estimate in the M- step. We also present a comprehensive Bayesian Cramer-Rao bound (BCRB) analysis of the proposed SBL-based schemes and present a detailed complexity analysis of the proposed scheme. Finally, the simulation results are presented to validate the theoretical bounds and illustrate the superiority of the proposed techniques.

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Title	***:***	***A novel time domain adaptive decision feedback qualization technique for cyclic code shift keying modulated wireless systems and convergence analysis of LMS and RLS algorithms***
Author(s)	***:***	***Vajjaramatti, Harshavardhan***
Roll No	***:***	***13104051***
Supervisor(s)	***:***	***Jagannatham Aditya K***

Abstract:

Cyclic Code Shift Keying(CCSK) is form of spread spectrum technique mainly used in applications such as military, global positioning systems(GPS), wireless local area network(WLAN) etc. Due to the frequency selective nature of the channel there is a problem of inter symbol interference, and if the channel is also time varying due to relative motion between transmitter and receiver, then it will be difficult to track channel variations, this motivates us to design adaptive channel equalization to solve above problems. In this work, we begin with the design of minimum mean square error(MMSE) and zero forcing(ZF) linear and decision feedback equalizers in time domain for CCSK modulated wireless systems assuming the perfect channel state information(CSI) at the receiver. Further the linear and decision feedback equalizers are developed based on the optimal delay which enhanced the mean square error(MSE) performance.In the second part of the thesis work, a novel time domain adaptive decision feedback equalization(ADFE) and adaptive linear equalization(ALE) receiver structures has been developed by employing least mean square(LMS) and recursive least squares(RLS) algorithms without CSI. The convergence analysis of LMS and RLS algorithms have been carried out based on the analysis of ensemble average learning curve for different step size parameters corresponding to LMS and RLS algorithms. Next unlike conventional analysis for unity forgetting factor, in this work the steady state error and misadjustment in RLS algorithm have been addressed for forgetting factor less than unity.Extensive simulations are carried out to demonstrate the MSE performance of LMS and RLS algorithms corresponding to different step size parameter and forgetting factor under moderately and severely distorted channel conditions. The theoretical and simulated curves are seen to be in close agreement with each other. Finally the simulations for bit error rate(BER) performances for both receiver architectures are carried out, and it is observed that for severely distorted channel conditions the novel decision feedback equalizers demonstrates the enhanced MSE and BER performances in comparison to that of the linear equalizers.

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Title	:	*Multiple beacon based robust decentralized detection in cooperative mimo wireless sensor networks*
Author(s)	:	*Ram Hukma*
Roll No	:	*13104054*
Supervisor(s)	:	*Jagannatham Aditya K*

Abstract:

In this thesis work, we consider the decentralized detection in cooperative multiple-input multiple-output (MIMO) wireless sensor network (WSN) which consists of multiple sensors and a fusion center. All the sensors and the fusion center are equipped with the multiple transmit and receive antennas respectively. We formulate the multiple beacon based novel decision fusion rules for two scenarios. In the rst scenario, the channel aware decision fusion rules has been derived where the fusion center is having perfect channel-state-information (CSI). The channel aware fusion rule is derived for two signalling schemes employed between the sensors and the fusion center namely antipodal signalling and non-antipodal signalling. In this scenario there is a stringent requirement of perfect CSI. Due to dynamic nature of wireless media one can only have CSI with limited accuracy. Accordingly, in the second scenario, the generalised likelihood ratio test (GLRT) based robust decision fusion rule has been derived which incorporates the knowledge of uncertainty present in MIMO channel estimates at the fusion center. The GLRT based robust fusion rule is derived for antipodal signalling employed between the sensors and the fusion center. Obtaining closed form expression for the GLRT based robust fusion rule with non-antipodal signalling is mathematically challenging and which has to be worked out in future. The analytical expressions for detection performance analysis parameters, i.e. probability of detection and probability of false alarm, at the fusion center has been derived for channel aware fusion rules. For the purpose of detection performance comparison receiver operation characteristics (ROCs) have been plotted considering di erent simulation parameters. Simulation results show that the channel aware detector performs best among all the proposed detectors and the GLRT based robust detector yields superior detection performance compared to the uncertainty agnostic detector.

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Title	***:***	***Interference Alignment For Linear Coherent Decentralized Parameter Estimation In Multiple Wireless Sensor Networks***
Author(s)	***:***	***Gorain Kanchan Kumar***
Roll No	***:***	***13104063***
Supervisor(s)	***:***	***Jagannatham Aditya K***

Abstract:

In this work, we have considered linear distributed estimation of Gaussian random vector parameter when multiple sensor networks are interfering each other. To nullify the inter network interference and efficiently use the available channel bandwidth with maximum throughput, interference alignment scheme is used. We have derived the BCRB (Bayesian Cramer Rao Bound) for the estimation of the vector parameter at the fusion center and it has been shown that LMMSE (Linear Minimum Mean Square Error) estimate achieves the BCRB for considered scenario when perfect interference alignment is achieved. We have also considered the total power constraint of a sensor network and have presented a close form expression for precoded amplify and transmit, precoded equal and precoded optimal power allocation scheme with interference alignment when the sensor observations are noiseless. However for noisy sensor observation the optimal power allocation is left as a future work. We further propose that sensor selection can significantly improve the performance of the system when considered in interference alignment framework and simulation result verify the claim. For sensor selection we have further proposed optimal exhaustive search sensor selection algorithm and two low complexity algorithm named as threshold based sensor selection and greedy sensor selection algorithm. The simulation results are also carried out to compare the performance and complexity of the algorithms.

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Title	***:***	***Battery Management Through Real Time Pricing***
Author(s)	***:***	***Pullela Venkata Aditya Prasad***
Roll No	***:***	***13104107***
Supervisor(s)	***:***	***Rajawat Ketan***

Abstract:

The introduction of smart devices, controllable batteries, renewable power sources, and smart metering systems allows users the opportunity to optimize their energy consumption on a day-to-day basis. Towards this end, utility companies are planning to introduce real-time pricing (RTP), wherein price per unit of electricity will be time-varying and depend on the average load profile and availability of resources. In this work, we consider the problem of storage management at the household level with RTP. Existing works formulate a complicated convex optimization problem to solve a simpler day-ahead pricing problem. The markov decision framework allows unknown prices, but is still too complicated to implement on a smart meter. We propose a real-time battery management system that outputs charging and discharging decisions per time slot. The algorithm utilizes the estimated state-of-charge (SOC) for taking decisions, and has an order of magnitude lower complexity than existing schemes. The mathematical model for the algorithm is developed, and the steady-state behavior is studied. Practical considerations, such as adaptive SOC estimation, on line load scheduling, excess loading, and renewable integration are also incorporated within the framework. Extensive simulations show the superior performance of the proposed algorithm over existing ones

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Title	***:***	***Spatiotemporal Colorization of Video Using 3D Steerable Pyramids***
Author(s)	***:***	***Paul Somdyuti***
Roll No	***:***	***13104143***
Supervisor(s)	***:***	***Gupta Sumana***

Abstract:

Colorization refers to the process of producing a coloured image/video from a given monochrome image/video. In this work, we develop a new approach for video colorization through spatiotemporal propagation of colour from the colour scribbles which are marked by the user on a selected set of keyframes. The keyframe selection is performed by adaptively thresholding a dissimilarity measure derived from the change in dominant orientation response of steerable filters with respect to the nearest keyframe. The spatiotemporal colour propagation within the video volume is carried out using the dominant orientation responses of the output of a set of 3D steerable filters, steered to a predetermined number of orientations. The 3D steerable filters are used to perform a steerable pyramid decomposition of the video, and the dominant orientation response at each pixel of the video are found at each level of the pyramid. Since information about motion as well as texture of the video are embedded in the steerable pyramid, our approach eliminates the need of motion vectors, which are normally used to transfer colours from one frame to the next in the conventional video colorization techniques. This results in faster computation, and greater accuracy of colorization. At each level of the pyramid, priorities are assigned to the pixels based on the presence of other coloured pixels in the vicinity, as well as the spatiotemporal smoothness of the neighbourhood. Pixels are colorized in the decreasing order of priorities starting with the topmost level of the pyramid. At the topmost level of the pyramid 3D patches belonging to the spatiotemporally smoothest regions of the video are colorized, which correspond to static or almost static regions of the video, with relatively low texture content, followed by regions with more motion and texture content at the lower levels of the pyramid. Experimental results demonstrate that our approach can effectively colorize videos with different types of motion and visual content with better accuracy and lesser computational requirements as compared to the conventional video colorization techniques.

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Title	:	*Stochastic resource allocation in device to device communication*
Author(s)	:	*Kandula Surya Viswanadh*
Roll No	:	*13104065*
Supervisor(s)	:	*Rajawat Ketan*

Abstract:

With the rapid proliferation of internet-connected mobile devices, the demand for high data rates has increased beyond what base stations (BS) can handle. A new technology in this regard is Device to Device (D2D) communications, where the BSs can offload its traffic to pairs of neighboring mobile users. An important problem in this context is that of mode selection, where one must decide if the data is to be routed through the BS or directly. In either case, power and rate allocations must also be decided, based on the available channel state. This thesis formulates the joint resource allocation and mode selection problem in D2D communications. Assuming full channel knowledge at the BS, the problem is posed as that of maximizing the utility, subject to stochastic rate constraints. We solve this optimization problem using Stochastic subgradient algorithm in dual domain. On an average, the allocated resources converge to their near optimal values if the step size parameter is close to zero. The simulation results proved the efficacy of the proposed algorithm.

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Title	***:***	***Calibration and mapping for soot monitoring***
Author(s)	***:***	***Singh Pradyumn***
Roll No	***:***	***13104100***
Supervisor(s)	***:***	***Rajawat Ketan***

Abstract:

Soot is a major pollutant emitted from manufacturing industries, biomass burning and wood & crop residues due to incomplete burning of hydrocarbons. Black carbon (BC) and Elemental carbon (EC) are major component of soot and a prime contributor to global warming. To asses and control it's regional impact in remote locations, comprehensive and low-priced measurement techniques are needed. A developed photo-reference method of measuring soot remotely is economical, wireless and requires low-power. In this theses, we have developed optimal regression model to describe the relationship between surface Black Carbon of a an aerosol loaded quartz filter and reflectance value (pixel value)of captured image of same loaded filter. We have made use of an special filter holder instrument which is used to keep the loaded filter in some special light conditions and a digital camera is used to take the picture of the loaded filter. Regression analysis is employed to choose the best regression model which can be used for future predictions of BC concentration most accurately using image pixel values of loaded filter image (linear or non-linear) among candidate models. In particular, Akaike Information Criterion selects the regression model which minimizes the statistical distance between true model and chosen model. We showed Red & Green pixel value of loaded filter image in presence of red light inside the filter holder instrument are among best predictors as compare to others. In the later part of this theses, the problem of mapping of pollution concentrations amid known sampler locations, using known concentrations at sampler locations is considered. A three layer Artificial Neural Networks called Radial Basis Function Network as Gaussian activation functions is brought in play for smooth interpolation of pollution amid sampler locations. It is shown that the prediction error is acceptable even without full knowledge of the environmental parameters.

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Title	***:***	***Channel Tracking and Estimation Transmit Beamforming With Frugal Feedback using KF And Quantized-KF Approach***
Author(s)	***:***	***Kumar Rajeev***
Roll No	***:***	***13104113***
Supervisor(s)	***:***	***Rajawat Ketan***

Abstract:

Channel state information at the transmitter (CSIT) is important for a large number of communication systems that rely on transmit beamforming or interference alignment for increasing the signal-to-interference-plus-noise ratio. The use of CSIT however incurs a huge amount of overhead, since CSI can only be estimated at the receiver, and must be fed back to the transmitter. It is possible to reduce the amount of feedback severaly in slow-fading environments, where the channel variations are not fast enough. Towards this end, a sign- of-innovations Kalman lter (SOI-KF) has been proposed that allows the receiver to simply feedback the sign of the innovation term appearing in the Kalman lter at each time slot. Thus, the SOI-KF incurs an overhead of one bit per block. A number of quantized KF (Q- KF) have also been proposed, where 2 or more bits can provide better performance. This thesis proposes a quantized version of KF (Q-KF) that aims to reduce the feedback overhead to less than one bit per time slot. Towards this end, the idea is to send no feedback when the innovation term falls below a threshold. The proposed QKF provides a continuous trade o between the communication cost with performance. Analytical results for the MSE of the proposed algorithm are also presented and compared with the simulation results.

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Title	***:***	***Distributed cooperative localization via ADMM***
Author(s)	***:***	***Jain Rahul***
Roll No	***:***	***13104110***
Supervisor(s)	***:***	***Rajawat Ketan***

Abstract:

Localization is the problem of primary importance in wireless sensor and ad-hoc networks. Accurate and low cost localization of nodes is important in many applications, as in most of the cases the data collected from the sensor is meaningful only with the relevant location. Mathematically however, the cooperative localization problem is non-convex, and therefore difficult to solve in a distributed fashion. This thesis introduces an ADMM-based algorithm for solving non-convex problems in a distributed scenario. The proposed algorithm is partially asynchronous, and can handle some erroneous or delayed updates. Using mild assumptions, convergence to the stationary point is shown. We have applied the algorithm to the cooperative localization problem where the nodes converge to locally optimum coordinates via consensus. Computer simulations show that the performance of the proposed algorithm is better then the existing synchronous as well as asynchronous algorithms.

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Title	***:***	***GLRT based target detection in monostatic MIMO RADAR systems***
Author(s)	***:***	***S Jyothsna***
Roll No	***:***	***13104061***
Supervisor(s)	***:***	***Jagannatham Aditya K***

Abstract:

This work presents a target detection technique in mono static MIMO radar when the RCS coefficients of the scattering scene is deterministic and unknown quantity. GLRT based test statistics is derived in which scattering scene coefficients are estimated by using maximum likelihood (ML) estimation. Further the above framework is also extended for a scenario with unknown noise variance. Also, the asymptotic detection performance for the above detector is obtained. The ML estimation used to estimate the scattering scene RCS coefficients, achieves the CRLB bound. We have also extended the GLRT based detection statistics for a framework with reduced number of range cells , to increase the angular resolution at the cost of slight increase in complexity. The performance of the GLRT detector is compared with that of energy detector and the proposed detector shows a better performance in terms of ROC. The above detection paradigm is also extended for moving target detection scenario. We have employed an iterative minimization of least squares error for the case where the entire scattering scene under consideration moves with the same velocity to find the radial velocity of target. Simulations are presented to validate the results.

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Title	***:***	***A Novel Bandwidth Efficient Channel Estimation Scheme In Ostbc-Mimo-Ofdm Systems Using Superimposed Pilots***
Author(s)	***:***	***S Sagar***
Roll no	***:***	***13104129***
Supervisor(s)	***:***	***Jagannatham Aditya K***

Abstract:

This work proposes a novel bandwidth efficient channel estimation scheme which utilizes only a fewer number of pilot sub-carriers by employing the superimposed pilots (SIP) based strategy. A novel precoding and decoupling matrices are designed to nullify the unknown data and the SIP during channel estimation and data detection, respectively. The proposed scheme is employed on spatially uncorrelated channel to perform channel estimation in time domain using minimum mean square error (MMSE) and least square (LS) estimators. For each of these estimators, a novel tractable closed form optimal SIP structure are designed which minimizes the mean square error (MSE) under the constraint of total transmitted SIP power. Cram´er-Rao bound (CRB) and Bayesian Cram´er-Rao bound (BCRB) are derived for LS and MMSE estimators, respectively. A closed form exact bit-error-probability (BEP) expression is derived for the square orthogonal space time block coded multiple-input-multiple-output orthogonal frequency division multiplexing (OSTBC MIMO-OFDM) systems in the presence of channel estimation error. Comparing to the existing scheme, simulations demonstrate that, for an MMSE estimator, the proposed scheme performs similar in terms of MSE and bit-error-rate (BER) under the constraint of equal total pilot power and equal data power per symbol and outperforms in terms of bandwidth (BW) efficiency.

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Title	***:***	***Optimal Target Detection and 3-D MUSIC based Parameter Estimation for Bistatic MIMO Radar Systems***
Author(s)	***:***	***Mittal Neha***
Roll No	***:***	***13104090***
Supervisor(s)	***:***	***Jagannatham Aditya K***

Abstract:

This work presents novel schemes for multi-dimensional target detection and estimation for a bistatic multiple-input multiple-output (MIMO) radar system with uniform linear array at the transmitter and the receiver. We have developed an optimal detector in Neyman Pearson sense for deterministic unknown radar cross section (RCS) and have derived the closed form expressions for probability of detection and probability of false alarm. Maximum Likelihood estimation has been used to estimate the RCS. It is extended to the case when target RCS is a random quantity. Receiver operating characteristics (ROCs) have been plotted for different values of number of transmit/receive antennas and is compared with energy detector. Further, we have discussed the joint estimation problem of direction of departure (DOD), direction of arrival (DOA) and Doppler frequency using multiple signal classification (MUSIC) algorithm. We have proposed a reduced dimension algorithm for estimation of the above mentioned parameters for multiple targets. The advantage of proposed scheme is that it provides automatic pairing. Finally, simulations are presented to validate the results.

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Title	***:***	***Robust precoder design for decentralized estimation in wireless sensor networks***
Author(s)	***:***	***Narayana B Bhargav***
Roll No	***:***	***13104025***
Supervisor(s)	***:***	***Jagannatham Aditya K***

Abstract:

In this work, we present a robust precoding scheme towards linear decentralized estimation of source parameter in a wireless sensor network (WSN). We consider a coherent multiple access channel between the sensors and the fusion center. The actual channel state information between the sensor nodes and the fusion center are imprecise and it is modeled to be located in an ellipsoid centered about the channel estimate. First we consider the problem of finding the robust precoder when the source parameter to be estimated is a scalar. We propose a worst-case design approach where the mean square error of the parameter is minimized for the least favorable channel located in an ellipsoid centered about the estimated channel in a Single Input Single Output (SISO) scenario. Next, we design robust precoders for Multiple Input Multiple Output (MIMO) WSN to estimate a vector parameter by assuming that the observations at the sensor nodes are noiseless. The proposed schemes result in an optimal parameter estimate at the fusion center with minimal processing at the fusion center. The robust precoder design is cast as convex optimization problems with second-order conic constraints which can be solved efficiently with existing tools.

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Title	***:***	***Analysis Of Spatially Modulated Systems For Spectrum Sensing And Cooperative Communication Applications***
Author(s)	***:***	***Goel Amish***
Roll No	***:***	***10327071***
Supervisor(s)	***:***	***Jagannatham Aditya K***

Abstract:

In this work, we analyze the performance of spatially modulated systems for the problems of spectrum sensing and cooperative transmission. Spatial Modulation is a recently proposed technique that aims to strike a trade-off between energy efficiency and spectral efficiency of the communication system. Several novel schemes are proposed for spectrum sensing of the cognitive radio systems with spatially modulated (SM) multiple-input multiple-output (MIMO) primary users. A composite hypothesis testing approach is used to model the unknown parameters in the system. In particular, the generalized likelihood ratio test (GLRT) based detector is initially developed, followed by the correlator, low complexity Linear GLRT and the energy detector (ED). Further, closed form expressions are derived for the probability of false alarm and probability of detection to characterize the spectrum sensing performance of the proposed schemes, employing also some results from extreme value theory. Simulation results are presented to demonstrate the performance of the proposed spectrum sensing schemes for SM systems and verify the analytical results. Next, the MIMO cooperative systems, with one relay node and using selective decode and forward (DF) protocol for transmission at relay, are investigated. In particular, the performance of the system is analyzed when the source and relay employs space-time block coded spatial modulation (STBC-SM) scheme for transmission. The system performance is compared with cooperative Alamouti-STBC scheme and the non-cooperative transmission of the codewords. The high signal to noise ratio (SNR) performance is investigated to derive the diversity order of the system. Finally, the optimal power allocation between the source and relay is derived and simulation results are provided to show the improvement over the uniform power allocation scheme

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Title	***:***	***Performance analysis of decode and forward protocol based cooperative communication systems***
Author(s)	***:***	***Dadige Sree Moorthy***
Roll No	***:***	***13104035***
Supervisor(s)	***:***	***Jagannatham Aditya K***

Abstract:

In this thesis, we study the performance of selective decode-and-forward relaying based MIMO cooperative communication system by employing the quasi orthogonal space time block codes(QOSTBC) at both source and relay nodes. We also show that performance of the system is improved by employing QOSTBC coding when compared to orthogonal space time block codes(OSTBC) for more than two transmit antennas. A comprehensive analysis of the end to end pairwise error probability is provided for Jafarkhani, TBH and SP kind of the QOSTBC coding schemes. We then derive the asymptotic approximation of the PEP which gives the insight of the diversity order of the system. In addition, we investigate the selective DF relaying based free space optical(FSO) cooperative communication system over the long range(weak,moderate and strong) of atmospheric turbulence conditions. We have considered the Gamma-Gamma distributed Irradiance factor for the purpose of analysis and to account all the possible atmospheric turbulence conditions. We have derived an upper bound on the SER of the system for MPSK modulation scheme and calculated a very close approximate SER expression for BPSK modulation scheme. Finally concluded the work by deriving an expression for diversity order for the above system.

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Title	***:***	***Multi-User Beamforming in Frequency-Selective MIMO MC-CDMA systems***
Author(s)	***:***	***Dadhania Vishwa Chandulal***
Roll No	***:***	***13104034***
Supervisor(s)	***:***	***Jagannatham Aditya K***

Abstract:

In this thesis, we intend to deal with the multi-user interference (MUI) present in frequencyselective multiple-input multiple-output multi-carrier code division multiple access (MIMO MC-CDMA) wireless systems. Design of precoders in frequency-selective scenario will yield an intricate structure which is difficult to solve. Unlike the computationally inefficient and conventional approach of considering the equivalent multi-user multiple-input multiple-output (MU MIMO) channel in the frequency domain, we attempt to design novel precoders for elimination of the MUI in time domain. In this direction, the multi-path multi-carrier decorrelator (MMD) receiver structure is employed at each user to exploit the available multi-path diversity of the frequency-selective channel which successfully reduces the MIMO MC-CDMA system under consideration into an equivalent frequency flat MU MIMO system with appropriate dimensions. Thereby, it opens up a way to apply various transmit preprocessing techniques which can efficiently cancel the MUI from the received data at each user. Firstly, a well-known generalized form of channel inversion namely the "block diagonalization(BD)" technique, suitable for multi antenna receivers is studied. It is observed that while on one hand MMD receiver scales up the dimensions in terms of number of available multipath components, the BD technique on the other hand strictly works for nulling complete MUI in the system as a consequence of which the number of users that the system can support reduces. To overcome this shortcoming, we develop a joint path and antenna selection algorithm which performs selection of receive antennas from the set of all available multipaths at each user and feeds back the selected paths to the base station(BS) for the design of the appropriate zero-forcing precoders. Secondly, the successive optimization framework is considered wherein the "successive constrained eigenbeamforming (SCEB)" technique exerts a comparatively less stricter constraint on the number of active users in the system since it does not concentrate on removing the complete MUI present in the system. In this context, the study of the various preprocessing techniques used in conjunction with orthogonal codes finally leads us to provide some useful insight on the sum rate capacity achieved and the number of users successfully supported in a MIMO MC-CDMA wireless system.

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Title	:	*Depth estimation from single image using texture and defocus cues*
Author(s)	:	*Srikakulapu Vivek*
Roll No	:	*13104146*
Supervisor(s)	:	*Gupta Sumana&Venkatesh K S*

Abstract:

The challenging problem of depth estimation from single 2D image is an active field of research in image processing. The motivation behind this work is the application of depth estimation for 3D scene reconstruction. As imaging is a process of 2D projection of a 3D scene, the depth information is lost at the time of image capture from conventional camera. This depth information can be inferred back from a set of visual cues present in the image, namely monocular and binocular depth cues respectively. In this thesis, we present a model that combines two monocular depth cues namely Texture and Defocus, for converting the 2D image back to 3D image. Depth is related to the spatial extent of the defocus blur by assuming that more an object is blurred, the further it is from the camera. At first, we estimate the amount of defocus blur present at edge pixels of an image. This is referred to as the Sparse Defocus map. Using the sparse defocus map we generate the full defocus map. However such defocus maps always contain hole regions and ambiguity in depth. To handle this problem an additional depth cue, in our case texture has been integrated to generate better defocus map. Texture integration in defocus map estimation mainly focuses on modifying the erroneous regions in defocus map by using the texture energy present at that region. The sparse defocus map is corrected using texture based rules. The hole regions, where there are no significant edges and texture are detected and corrected in sparse defocus map. We have used region wise propagation for better defocus map generation. The accuracy of full defocus map is increased with the region wise propagation. The main contribution of this work lies in achieving an increased accuracy of defocus estimation by hole filling, integrating texture information with defocus cue and using region wise propagation.

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Title	***:***	***Reversible Watermarking in Images using Difference Expansion***
Author(s)	***:***	***Patel Hemant***
Roll No	***:***	***10327296***
Supervisor(s)	***:***	***Gupta Sumana***

Abstract:

In the age of Internet, where digital information is rampant, ownership and copy- right issues have inspired researchers to develop robust watermarking techniques for images and videos. In this work, we present a method of reversible watermarking for images. To embed watermark bits we use edge pixels present in image. Most of the existing techniques in reversible watermarking use location identification bits to retrieve the pixels where watermark bits were embedded. Much of the embed- ding capacity is usually consumed by location identification bits. Hence total space available for watermark bits reduces. By using edge pixels for embedding, we are eliminating the use of any location identification bits. Most of edge pixels have high intensity values and our human visual system (HVS) is less sensitive to changes in high intensity pixels. Hence perceptual distortion due to edge pixel pair transforma- tion is also less. We use difference expansion (DE) to transform pair of edge pixels because transformed pixel's values are much closer to their original values. By trans- forming edge pixels only, we are usually altering only 10% to 15% of total pixels in image. This helps in reducing the perceptual distortion. We test our method on 65 images, which includes general, medical and military images. Embedding capacity and amount of data recovered varies depending on the texture of image. We validate the performance of proposed algorithm in terms of mean squared error (MSE), peak signal-to-noise ratio (PSNR) and structural similarity (SSIM) index. For medical images relatively better results are produced.

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Title	***:***	***Learning Dynamical Processes Over Graph Via Ssdl***
Author(s)	***:***	***AlatkarPrasad Bapurao***
Roll No	***:***	***13104011***
Supervisor(s)	***:***	***Rajawat Ketan***

Abstract:

We consider the problem of prediction of dynamical processes over graphs. Such problems occur in the context of social networks and in network monitoring. As the graph size increases, it becomes impractical to take measurements or observations at each node. This thesis proposes a dictionary learning-based technique that allows interpolation and prediction of such missing entries. Using the network topology and some training data, a dictionary is built to reconstruct the underlying process occurring over network. The topology information is incorporated by utilizing a semi-supervised regularization term that encourages smoothness over the graph. Semi-supervised learning combined with dictionary learning techniques are used to reconstruct the underlying process from partial observations. The trained dictionary can predict the process in online fashion from partial observations solving regularized least squares problem. The learned dictionary can also help with classifying the network process. The online algorithm proposed for prediction and classification of processes takes into account both spatial and temporal correlations of underlying processes.

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Title	***:***	***Online Tracking Of Low Rank Matrices From Partial Observations***
Author(s)	***:***	***Mohan Boda***
Roll No	***:***	***13104030***
Supervisor(s)	***:***	***Ketan Rajawat***

Abstract:

Low rank matrix completion is a problem where a number of missing entries of a matrix are estimated using only a few observed entries. Such matrices occur in the context of network monitoring, collaborative ltering, and video processing. There exist e cient o -line algorithms which are capable of completing large matrices. Popular examples include Singular Value Thresholding (SVT), Fixed point Continuation Algorithm (FPCA), OPTSPACE, and Geometric methods such as GROUSE and GRASTA. This work considers the problem of tracking low rank incomplete matrices that observe many practical scenarios. The proposed methods can be classi ed into two broad cate- gories. The online methods, such as SVT-LMS, soft-thresholding, and sub-gradient-based methods can complete slowly changing matrices with high accuracy. These methods are also cheap, simple, and fast compared to existing state-of-the-art methods. For highly time-varying matrices, the thesis puts forth a class of smoothing methods that operate with a constant amount of lag. While the smoothing techniques proposed are more com- putationally intensive, they yield signi cantly better accuracy, and converge within a few iterations. The proposed techniques outperform existing techniques when compared over data collected from network monitoring logs and over video samples.

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Title	***:***	***Optimal Encoder Design & Sensor Scheduling in Wireless Sensor Network***
Author(s)	***:***	***Kumar Sumit***
Roll No	***:***	***13104147***
Supervisor(s)	***:***	***Rajawat Ketan***

Abstract:

Wireless sensor networks (WSNs) are spatially distributed systems consisting of several low-cost, resource-constrained sensors which transmit sense data to a fusion center. WSNs are used in applications such as environment monitoring, surveillance, search and rescue,disaster relief, and many more. Detection of weak signal is of primary interest for most of the WSN applications. This thesis considers the problem of sensor selection for weak signal estimation. The sensors observe a weak signal, burried in noise, and transmit it to the fusion center. Prior to transmitting the observations to data fusion center, sensors perform linear precoding on observations to minimize the mean square error at fusion center. The fusion center receives the sensor transmissions coherently, and utilizes the MMSE estimator in order to recover the sensed signal. In order to select the best set of sensors, the log determinant of the estimation error covariance matrix is utilized. We show that the final objective function is in the form of difference between two submodular functions. It is shown that the resulting function is submodular in the set of sensors, and has special properties that can be utilized for sensor selection. By minimizing objective function we select optimum sensors and show that tuning of trade-off parameter result in trade between number of sensors selected and estimation accuracy.

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Title	***:***	***On Optimal User Pairing and Opportunistic Interference Alignment in Interference Channels***
Author(s)	***:***	***Sinha Atul Kumar***
Roll No	***:***	***10327171***
Supervisor(s)	***:***	***Chaturvedi Ajit Kumar***

Abstract:

Interference alignment is an advanced interference management technique which exploits multiple signaling dimensions in wireless networks in order to achieve maxi- mum Degrees-of-Freedom (DoF). In this thesis, we focus on exploiting user diversity to improve the performance of interference channels by using interference alignment. We consider a network with K base stations (BS) and N users (N >= K) in which each BS is allowed to transmit to at most one user. We consider the scenario where channel state information (CSI) is available at the receivers and transmitters. Using CSI, we try to determine the BS-user pairing which maximizes the sum-rate. We propose the optimal user pairing algorithm for maximizing the achievable sum-rate and demonstrate the gains in sum-rate performance, theoretically as well as through simulations. Next, we propose a low complexity user pairing algorithm which em- ploys coordinate ascent approach and achieves sum-rate close to that of the optimal algorithm. Next we relax the assumptions of channel state information at transmitters and cooperation among them. It is not possible to attain interference alignment through conventional methods in such scenarios. We propose a low complexity opportunistic interference alignment (OIA) algorithm which exploits the available user diversity in order to align the interferences through user selection and is based on a very low overhead feedback scheme. It is shown that if the number of users in every cell is scaled with respect to the transmit power, a feasible target sum-DoF can be achieved. Lastly we extend the user selection based OIA algorithm to the case of user pairing. We illustrate, both, analytically and through simulations that in a K- transmitter network, user pairing can provide a K-fold gain over user selection in terms of total number of users required to achieve similar sum-rate or sum-DoF performance. Similar to the case of OIA with user selection, a feasible target sum- DoF could be achieved with user scaling.

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Title	***:***	***Energy Harvesting Cognitive Radio : Save-Sensing-Transmit Tradeoffs under Primary User Traffic***
Author(s)	***:***	***Sirigireddy Sudhakar Reddy***
Roll No	***:***	***13104142***
Supervisor(s)	***:***	***Banerjee Adrish***

Abstract:

Spectrum efficiency and energy efficiency are important factors in designing wireless networks. Cognitive radio technology can improve spectrum efficiency through dynamic spectrum access. Radio Frequency (RF) energy harvesting is a promising technique to power wireless networks and thereby improve energy efficiency. Therefore, to attain both spectrum and energy efficiency, we can incorporate the RF energy harvesting capability in Cognitive Radio Networks. We consider a self-powered Cognitive Radio system in which Secondary User (SU) has no fixed power supply (e.g batteries) and extracts energy exclusively via ambient radio signal. Because of hardware limitations, SU can not perform RF energy harvesting and spectrum sensing simultaneously. Therefore, we divide the time slot of SU into three non overlapping sub slots exclusively for energy harvesting, spectrum sensing and data transmission respectively. Here we consider that the Primary User (PU) is not synchronized with time slot structure of Secondary User, that means PU changes its status at any time within the time slot of SU. We focus on maximizing the SU throughput by considering the trade off between three sub slots with random arrival and departure of PU within the time slot of SU. We formulate the SU throughput optimization problem in form of Mixed Integer Non Linear Programming (MINLP) and derive the optimal duration of energy harvesting, spectrum sensing and detection threshold using the Differential Evolution Algorithm. We present the in-depth numerical analysis how the SU throughput is affected by the PU traffic, sensing SNR and energy harvesting rate. The throughput of SU is decreasing with the increase of PU traffic. Throughput of SU is increasing With increase in energy harvesting rate and with sensing SNR.

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Title	***:***	***Voice Activity Detection using Deep Belief Networks by source and system level information fusion***
Author(s)	***:***	***Arya Devanshu***
Roll No	***:***	***10327229***
Supervisor(s)	***:***	***Hegde Rajesh Mahanand***

Abstract:

Voice Activity Detection(VAD) is an elementary task in all speech related applications such as speech recognition, speech coding, speaker diarization and speaker verification. Its main aim is to determine the existence of human speech from an audio signal. In an ideal scenario, this can be done by simply thresholding energy of signal. However, the most challenging problem of VAD is to make it perform when the signal is corrupted by noise and the signal-to-noise ratio (SNR) drops below 10dB. Numerous approaches has been proposed to tackle this problem that with a variety of feature extraction domains and decision making algorithms. In this thesis, a noise robust VAD algorithm is proposed using source-filter theory of human speech production. In general, source based information is not considered in standard VAD methods. However, it is shown that source based features possess valuable information about speech part of signal even at very low SNR . The aim of this work is to investigate the joint use of source and system level features and show the significance of merging long term information to them, in order to develop a VAD model. Finally, to fuse the advantages of multiple features from different domain for the robustness of VAD, Deep Belief Network(DBN) based approach is proposed. The DBN based VAD extracts a new feature that can fully express the advantages of all features by transferring them through multiple non linear hidden layers. As compared to the existing machine learning based VADs which only utilize shallow models, the model developed in this work introduces a deep model for the multiple feature fusion task in VAD. The proposed algorithm uses a lesser dimensional feature as compared to state-of-the-art DBN model.

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Title	***:***	***Joint Source Localization and Separation Using Sparsity Based Methods***
Author(s)	***:***	***Kalkur Sachin N***
Roll No	***:***	***13104127***
Supervisor(s)	***:***	***Hegde Rajesh Mahanand***

Abstract:

Blind source separation has been an active research topic with an aid to important practical application such as Acoustic holography and Speech recognition. On the other hand sparse reconstruction methods for source separation have been extensively studied and applied time-frequency domain but its study in spatial domain is very limited.\par In this thesis, we propose a novel joint source localization and separation method using a sparse reconstruction framework. This task is facilitated by the data model in spherical harmonic domain, eliminating the dependency between source locations and source strengths, which is generally observed in the standard data models. Subsequently, the problem is formulated as an optimization problem with an orthogonality constraint. Necessity of the orthogonal constraint has been described in detail. The solution to the problem is obtained using splitting method based on bregman iterations. The sparse vector obtained by solving a nonconvex problem facilitate the process of determining source locations.\par Experiments are performed on various datasets at different SNRs to evaluate the performance of the proposed method. The localization results have been evaluated using RMS error and the separation of sources from the mixture is evaluated using performance metrics such as LSD, PESQ and SDR. Accordingly, the proposed methods is reasonably better compared to the standard techniques in the literature. Subsequently, the proposed method converges in lesser iterations illustrating the fact of lesser complexity. The issue of frequency dependency has been resolved and optimal frequency selection is presented. Finally in this thesis, we have highlighted the importance of spatial sampling and spherical harmonic noise and propose possible future work of source separation with varying harmonic order.

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Title	***:***	***Preamble Based Channel Estimation in GFDM***
Author(s)	***:***	***Ghatak Gourab***
Roll No	***:***	***13104048***
Supervisor(s)	***:***	***Banerjee Adrish***

Abstract:

Existing preamble based channel estimation techniques give no consideration to the out of band (OOB) radiation of the transmit preambles. Novel communication schemes like Generalized Frequency Division Multiplexing (GFDM) require the transmission to have low OOB radiation. Two particular preamble design techniques are proposed and their performance is analyzed in terms of OOB radiation and MSE. Improvement schemes are studied to cater to the needs of practical scenarios in which reduced length preambles are considered and a pinching technique is used to further reduce the OOB radiation. The obtained preambles are shown to have 5 to 20dB lower OOB radiation than the existing preamble based estimation techniques. The estimated channel values are used in equalization of GFDM systems that are aimed for transmit diversity and their performance is compared to equalization with perfect channel knowledge. The Minimum Mean Squared Error (MMSE) estimation leads to better results than the Least Squares (LS) estimation technique.

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Title	***:***	***On Redundancy Rate of SWLZ and FDLZ Algorithms and on Exponential Rates for Generalised AEP and Waiting Times***
Author(s)	***:***	***Jain Ayush***
Roll No	***:***	***10327181***
Supervisor(s)	***:***	***Bansal Rakesh K***

Abstract:

In the first part of this thesis we obtain a number of results related to redundancy rate of fixed database Lempel-Ziv (FDLZ) algorithm, sliding window Lempel-Ziv (SWLZ) algorithm and a variant of FDLZ algorithm by Wyner and Wyner. First we improve the upper bound on the contribution of pointer bits to the compression ratio for fixed database Lempel-Ziv (FDLZ) algorithm to be $ H+O(1/\log_2 n) $, from the previous bound of $H+H(1+o(1))\frac{{\log_{2}\log_{2}n}}{{\log_{2}n}} $ to obtain the improved upper bound of $H(1+o(1))\frac{{\log_{2}\log_{2}n}}{{\log_{2}n}} $ on redundancy rate, which matches the existing lower bound to the first order term. Here H denotes the entropy rate of the source and n is the size of the database. For the variant of FDLZ suggested which uses two databases to encode the phrase length, we obtain an upper bound on the redundancy rate equal to $O(1/\log_2 n) $. Next we obtain improved upper bound on redundancy rate for the SWLZ algorithm. We obtain a pathwise upper bound of $ H(1+o(1))\frac{{\log_{2}\log_{2}n_{w}}}{{\log_{2}n_{w}}}$, on the redundancy rate for this algorithm, for sources satisfying Markov condition. Here n_{w} denotes the window size. In the second part of this thesis we analyse the rate of convergence of waiting times $ W_{n}(D) $, until a $ D- $close version of the first $ n $ symbols of a realization of a process appears in the realization of another independent process and the rate of convergence in generalized asymptotic equipartition property (AEP). Statistics of Waiting times $ W_{n}(D) $ plays the key role in analysis of lossy version of FDLZ algorithm. We first relate rate of convergence of waiting times $ W_{n}(D) $ with rate of convergence in generalized AEP. We then identify the conditions under which exponential rates of convergence holds in generalized AEP and for waiting times.

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Title	:	*Detection and Removal of Cracks from Digitized Artworks*
Author(s)	:	*Bansal Ankit*
Roll No	:	*13104015*
Supervisor(s)	:	*Gupta Sumana*

Abstract:

Ancient paintings and artworks contribute to cultural heritage. Such ancient artworks degrade due to aging, drying and mechanical factors. With increasing imaging tools, image processing methodologies are being developed to analyze, preserve and restore the cultural heritage in form of digitized artworks. Most prominent artifact in these are undesired random patterns called Cracks or Craquelure. Such cracks degrade the perceived image quality. Various image processing methodologies are used to detect the cracks and restore the missing part of the digitized artwork. We propose a method which uses morphological operations to detect the cracks and other image processing methodologies to reduce the miss detection. Cracks have low luminance and by making use of this feature of cracks, at first, we preprocess the image to enhance the contrast to detect the cracks also present in dark regions. After preprocessing, we apply morphological operations to detect the cracks and smoothen it using a filter. Finally, we threshold the image to extract the cracks and remove components with area smaller than a user defi ned parameter. This gives us the fi nal crack map of the image. We compare the crackmaps of images using proposed method and existing methods. We show the quantitative analysis with the use of metric to fi nd true detection, false detection and miss detection of crack pixels with the use of few images. We restore the images by K-SVD based sparse representation. We compare the results of restoration with other techniques such as simple median filter, modi fied median filter and exemplar based inpainting.

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Title	***:***	***Subspace Based Domain Adaptation for Visual Recognition***
Author(s)	***:***	***Raj Anant***
Roll No	***:***	***10327086***
Supervisor(s)	***:***	***Hegde Rajesh Mahanand***

Abstract:

Domain adaptation techniques aim at adapting a classifier learnt on a source domain to work on the target domain. Exploiting the subspaces spanned by fea- tures of the source and target domains respectively is one approach that has been investigated towards solving this problem. These techniques normally assume the existence of a single subspace for the entire source / target domain. In this work, we consider the hierarchical organization of the data and consider multiple subspaces for the source and target domain based on the hierarchy. We evaluate different subspace based domain adaptation techniques under this setting and observe that using different subspaces based on the hierarchy yields consistent improvement over a non-hierarchical baseline. Also, in the second part of the work, we propose sub- space alignment based domain adaptation of the state of the art RCNN based object detector [11]. The aim is to be able to achieve high quality object detection in novel, real world target scenarios without requiring labels from the target domain. While, unsupervised domain adaptation has been studied in the case of object classification, for object detection it has been relatively unexplored. In subspace based domain adaptation for objects, we need access to source and target subspaces for the bound- ing box features. The absence of supervision (labels and bounding boxes are absent) makes the task challenging. In this paper, we show that we can still adapt subspaces that are localized to the object by obtaining detections from the RCNN detector trained on source and applied on target. Then we form localized subspaces from the detections and show that subspace alignment based adaptation between these subspaces yields improved object detection. This evaluation is done by considering challenging real world datasets of PASCAL VOC as source and validation set of Microsoft COCO dataset as target for various categories.

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Title	:	*Musical tempo Estimation using Sub-band Synchrony*
Author(s)	:	*Chowdhury Shreyan*
Roll No	:	*10327697*
Supervisor(s)	:	*Hegde Rajesh Mahanand*

Abstract:

Tempo estimation and onset detection are two important aspects of music information retrieval. Onset detection aims to locate instances in a music audio where there are note onsets or percussive hits, while tempo estimation uses inter-onset intervals and other features to estimate the pace of the musical piece, measured in BPM (beats per minute). Tempo estimation has applications in music production and mixing, music classification, automatic playlist generation, and audio-visual synchronization, among other music technology tasks. Numerous methods have been proposed in literature for tempo estimation with varying accuracies, however, most are error prone and tend to fail for musical styles that do not have a strong, distinct and steady percussive beat going on. This thesis proposes three different approaches to address this issue. The first proposed method uses the fluctuation strength feature to detect the dominant amplitude modulation frequency in the audio and determines tempo based on the same. The remaining two methods detect onsets first, followed by estimating the tempo based on the onset curve. The spectral centroid method detects onsets by calculating the ``center of gravity'' of the spectrum at each time frame, and the sub-band synchrony method detects onsets by locating frames at which there are coherent changes in the envelopes of different auditory frequency bands. Sub-band synchrony has been shown to provide the best results for tempo estimation among the algorithms tested.

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Title	***:***	***EMG modeling using Bessel series expansion***
Author(s)	***:***	***Meena Narendra Kumar***
Roll No	***:***	***10327433***
Supervisor(s)	***:***	***Sircar Pradip***

Abstract:

In this thesis, we propose a novel approach to model the electromyography (EMG) signal using the Fourier-Bessel (FB) series expansion. We show that the FB series can be used to represent the EMG signal since complete reconstruction of the original non-stationary signal is possible if the signal is expanded using FB series. Thus, expansion of the signal in the FB series becomes a way to analyze the signal as well. The FB coefficients can be used to reconstruct the original signal. The EMG signals used are from tibialis anterior muscle of three subjects with myopathy, neuropathy and without any history of neuromuscular disease. The quality of the reconstructed EMG signal was evaluated by computing distortion measures namely the mean squared error (MSE), Itakura-Saito COSH measure, RMS log spectral measure and relative MSE. The proposed method has been compared to an existing method where the EMG is represented as a multicomponent time-varying amplitude and frequency modulated signal. It has been shown that our analysis technique leads to efficient modeling and data storage.

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Title	***:***	***Regularity Flow Inspired Target Tracking in FLIR Imagery***
Author(s)	***:***	***Kumar Nikhil***
Roll No	***:***	***13104199***
Supervisor(s)	***:***	***Venkatesh K S***

Abstract:

In this work, we present a novel and very simple approach of object tracking in FLIR (Forward Looking Infra-red) imagery utilizing spatio-temporal information of a video sequence. There are a number of fundamental differences between information content of visible and infra-red sequences like very poor (Signal to Noise Ratio) SNR, low dynamic range, dynamic nature of target signatures, dependence upon scene thermodynamics and effect of sun glint which make job of tracking more tedious in infra-red domain. Generally trackers need an initialization often done manually or by object detection, but in present approach there is no need to initialize the tracker. IR signatures of targets are more prominent than background and clutter, this contrast is commonly used as a clue for detection but in case of poor SNR and small target size detection based on this fact becomes more challenging. Present approach also relies on this contrast based clue but in place of detecting small targets limited in a couple of pixels in X− Y plane trajectory followed by targets is explored in X− T frame. A small group of frames of video sequence is taken to form a 3D data cuboid with X ,Y ,T axes, this cuboid is re represented as stack of contiguous X − T slices. As few of these X − T slices contain information related to trajectory of moving objects, with help of Hough transform based inclined line detection trajectory information is extracted from slices and used for labelling moving objects in X−Y plane. A dataset of infra-red sequences is generated having targets like tanks, AFVs and other targets of military importance in presence of substantial amount of clutter in variable atmospheric and thermodynamic conditions and results obtained demonstrate effectiveness and robustness of present approach.

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Title	***:***	***Hybrid Structured Peer to Peer Live Video Streaming Protocol***
Author(s)	***:***	***Saxena Abhishek***
Roll No	***:***	***13104005***
Supervisor(s)	***:***	***Singh Yatindra Nath***

Abstract:

A large number of applications on internet require simultaneous delivery of video contents to large number of users. Recently, peer-to-peer based live video streaming systems have emerged as a new paradigm to support over 100,000 concurrent users. In this thesis, a Distributed Hash Table (DHT) algorithm with minimal central control is presented which organises all the newly arrived peers into a structured overlay network in which binary tree acts as a backbone of the network and rest all peers are arranged in mesh with these binary tree nodes. This new hybrid structured peer-to-peer system utilises the advantages of both tree based overlay structure for low start up delays by pushing the video contents in small packets called chunks along the tree and of mesh based overlay structure for being less prone to peer churn dynamics by arranging most of the peers in the mesh part of the proposed network. A BitTorrent like peer-to-peer technology is used in the mesh part of the proposed network to support the live video streaming. Unlike BitTorrent, timely and continuous chunk delivery is must in live video streaming systems and thus a sliding window protocol is used to meet the constraint of playback deadline for each chunk. The thesis also explores all the key design factors like peer group size, number of fragments available for sharing and also the ideal fragment size for the optimization of the proposed network. Analytical study of the delay for the proposed network has also been done and further it is compared with the push and pull (with no peer-to-peer) methods. Lastly, the possible avenues for future directions are outlined.

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Title	:	*Sparsity-Based Source localization under Sensor Position Errors in Spherical Harmonic Domain*
Author(s)	:	*Gupta Avadh Bihari*
Roll No	:	*10327173*
Supervisor(s)	:	*Hegde Rajesh Mahanand*

Abstract:

Source localization is an important problem which finds wide applications including source separation, Electroencephalography (EEG), radar systems, and tracking. A large number of non-parametric and parametric approaches have been proposed for Direction-of-arrival(DOA) estimation in the past half centuries. Recently a class of semi-parametric algorithms based on sparse representation(SR) has attracted significant interest due to its capability in achieving high resolution and dealing with coherent sources but its applications to source localization in the spherical harmonics domain is very limited. Also, most of the techniques used for DOAs estimation are developed based on the assumption of exactly known array manifold which leads to inaccurate data model due to different kinds of perturbation exists in real scenario. In this thesis, a new sparse representation model is presented which is based on sparse reconstruction using a spherical microphone array. The source localization method proposed in this work addresses three important research issues. It formulates the source localization problem in the spherical harmonics domain as a sparse reconstruction problem. It focus on solving the problem of sparsity based DOA estimation in the presence of sensor position errors by taking sensor position errors as normally and uniformly random variables. Subsequently, a low complexity method to estimate the direction of arrival of multiple sources is also used by using partial elevation angle dictionaries. Including the statistical characteristics of perturbation and no Taylor approximation errors being introduced in the proposed SR model guarantee the superiority of the proposed model in robustness. Experiments like RMSE and Probability of Resolution of sources are performed on various datasets at different SNR, different source separations and different array order to evaluate the performance of the proposed model. The results are compared with the existing methods in terms of robustness and probability of resolution of uncorrelated sources. The proposed method outperforms the other methods over a long range of SNR.

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Title	:	*Performance Enhancement with energy efficient Dynamic Source Routing (DSR) protocol in Mobile Adhoc Network (MANET)*
Author(s)	:	*Singh Nirdesh*
Roll No	:	*13104092*
Supervisor(s)	:	*Singh Yatindra Nath*

Abstract:

Mobile adhoc network (MANETs) is an infrastructure-less network of mobile nodes that can be deployed anywhere at any-point of time. In MANETs there is no centralized server that can provide configuration as well as routing, so each node needs to perform distributively to establish communication among them.To facilitate communication via multiple hops, each node will serve the purpose of the host as well as the router for forwarding the data packets in the network. Each node consumes energy for communication in MANET. To improve network life time in MANET, nodes should be in sleep mode or in idle mode when they can. The primary challenge in MANET is that each node needs to continuously maintain the routing information in order to forward the packets. Due to continuously breaking and establishing routing paths, source node has to broadcast route request packet again and again. Thus, a suitable routing protocol is required in MANETs that can improve various network performance metrics. In the thesis, we propose a scheme to enhance network life time. As a result, source node will select a maximum energy routing for transmitting data to destination. Maximum energy route will stay for a long time and overall network performance will be improved. We have simulated with modified energy efficient DSR in ns-2.35 and compared various parameter with original DSR. We have consider random way point mobility model so that all the nodes in the network should have same speed but they are moving randomly to and fro in the network. The final conclusion shows that modified energy DSR has long network life time and the packet delivery ratio has also improved as compared to original DSR protocol

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Title	***:***	***Anonymity in Delay Tolerant Networks***
Author(s)	***:***	***Vasudevan Ajit Kumar***
Roll No	***:***	***13104002***
Supervisor(s)	***:***	***Singh Yatindra Nath***

Abstract:

Delay Tolerant Networks (DTN) are ideally suited for military applications considering the conditions of intermittent connectivity between nodes, long variable delays, asymmetric data rates etc that are common for military environment. Security of data and privacy are of utmost importance in a military application. In order for DTN to be practical in military, it must be able to keep the communication anonymous i.e. an adversary should not be able to gain information on the identity of the sender and receiver of a message. There are several challenges involved in achieving this in DTN since it is vulnerable to traffic analysis. PKI is not an effective mechanism for providing security in DTN due to the intermittent nature of these networks and key management is still an open issue in DTN. Anonymous communication is achieved in TCP/IP networks like Internet by using applications like TOR which basically provides onion routing and routes the packets through TOR servers. However onion routing needs the path to be known beforehand at the sender which is not always possible in DTN. This paper provides an anonymous communication mechanism - Anonymous Epidemic that provides anonymity in DTN and uses Combined Public Key (CPK) for key management. CPK is a practical and efficient mechanism for the conditions of DTN. We evaluate the performance of this routing mechanism in terms of Delivery Ratio and Average Latency and present the results.

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Title	***:***	***Fault Tolerant Clock Synchronization in Distributed Network using Weighted Average***
Author(s)	***:***	***Sharma P D***
Roll No	***:***	***13104001***
Supervisor(s)	***:***	***Singh Yatindra Nath***

Abstract:

To perform a task in coordinated fashion in distributed environment, we need the common notion of time. To achieve this purpose, clock synchronization is conceptualized. Clock drifting is inherent property of a clock, which necessitates the synchronization. A network consists of nodes which may behave or misbehave. The misbehaving nodes may pose problem in clock synchronization. We require a mechanism to mitigate the effect of misbehaving nodes. In this thesis, we present a weighted average clock synchronization algorithm to perform coordinated activity in a fault tolerant manner. We use the behaviour of the nodes to calculate normalized weight in localized fashion that lies between 0 to 1. This weight assignment enables us to suppress effect of misbehaviour up to some extent. This algorithm offers improved precision while tolerating misbehaving nodes. The upper bound on tolerance limit is one third of the network size. Our main contribution is to offer improved precision while tolerating misbehaving nodes.

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Title	***:***	***Video Compression Using Video Decomposition Technique***
Author(s)	***:***	***Nellur Naresh Shekhar***
Roll No	***:***	***13104086***
Supervisor(s)	***:***	***Gupta Sumana***

Abstract:

In the present era of digital world, video compression is essential in order to reduce the requirement of bandwidth in-terms of transmission and storage of videos. All existing video coding standards developed so far consider video as a sequence of natural frames formed in the XY-plane, and exploit spatial redundancy in XY-plane and temporal redundancy along T-direction to achieve compression. New redundancy reduction techniques such as Optimal Compression Plane have improved the performance of video compression for a number of coding methods in case of static videos that are captured with little camera motion combined with small amount of object motion. Compression of dynamic videos with high object motion combined with complex camera motion is a challenging task. We propose a composite adaptive preprocessing algorithm which integrates the concept of Optimal Compression Plane and Low-rank Sparse Decomposition. The proposed algorithm considers video as a 3D data cube, in which the frames are allowed to be formed in a non-XY plane to exploit the redundancy present in the video to fuller extent. Low-rank and Sparse Decomposition is performed in adaptively selected Optimal Decomposition Plane depending on the visual content of the video, to extract the global background information and reduce the amount of data to be compressed. The main contribution of this work lies in identifying optimal frame plane for decomposition. We evaluate the performance of the proposed redundancy reduction technique on video coders such as Motion JPEG, Motion JPEG 2000, H.264 Intra-only profile, and H.264 for videos with different visual content and present the results in terms of Rate-Distortion curves.

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Title	***:***	***Localization enhancement of wireless sensor networks***
Author(s)	***:***	***Aeddula Narasimha Reddy***
Roll No	***:***	***13104010***
Supervisor(s)	***:***	***Rajawat Ketan***

Abstract:

Wireless sensor networks are a significant technology attracting considerable research interest due to their emerging applications like smart building failure detection and reporting, and target tracking. In these applications it is necessary to accurately orient the nodes in the sensor network with respect to a global coordinate system in order to report data that is geographically meaningful. This thesis aims at improving localization accuracy using different techniques. The first technique involves the use of mobile nodes anchor nodes for increasing the accuracy of localization. The mobile nodes is moved to each quadrant in order to improve the location estimate of other nodes. The second technique considers spectrum sensing for localization of sensor networks. The goal is to utilize RF cartography, where the spatial distribution of the power spectral density if estimated using the basis expansion model. The general set up allows several transceivers willing to cooperate in estimating the location of each other, and uses the least-squares and lasso formulations.

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Title	***:***	***Fast CFO Estimation In OFDM Systems Using Golden Section Search Algorithm***
Author(s)	***:***	***M Rampriyan***
Roll No	***:***	***13104115***
Supervisor(s)	***:***	***Vasudevan Kasturi***

Abstract:

Orthogonal Frequency Division Multiplexing (OFDM) plays an important role in the implementation of high data rate communication. The OFDM system transmits data as a set of low symbol rate parallel data rate streams over orthogonal narrow band sub carriers. This equivalently converts the frequency selective fading channels to a number of narrow band flat fading channels thus combating the distortion or the inter-symbol interference of the multipath channel. However, the OFDM system is highly vulnerable to synchronization errors, mainly the carrier frequency offset (CFO), which, if left uncompensated results in the loss of orthogonality of the sub carriers, leading to significant bit error rate (BER) degradation. In this thesis, pilot symbols are used for the estimation of CFO. We use a golden section search method to estimate the CFO and compare it with the bisection method. Throughout the thesis we assume that channel and timing is known perfectly at the receiver.

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Title	***:***	***Spatio-Temporal Spectrum Hole Detection with Multiple Primary Users***
Author(s)	***:***	***Gargelwar Aniket Narendra***
Roll No	***:***	***13104046***
Supervisor(s)	***:***	***Rajawat Ketan***

Abstract:

Spectrum sensing is an important area of research in the context of cogni- tive radio networks (CRN).We consider multi-antenna cooperative spectrum hole detection in cognitive radio networks, when there may be multiple primary users which are poison point distributed in space. A detector based on the spherical test is analyzed in such a scenario. The false alarm and the detection probabilities, as well as the detection threshold and Receiver Operation Characteristics are available in closed form. Simulations are provided to verify the accuracy of the derived results.

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Title	***:***	***Preamble based Channel Estimation for an OFDM/OQAM system***
Author(s)	***:***	***Janapiridi Mahesh Prasad Dora***
Roll No	***:***	***13104057***
Supervisor(s)	***:***	***Kasturi Vasudevan***

Abstract:

Orthogonal Frequency Division Multiplexing/Offset Quadrature Amplitude Modulation (OFDM/OQAM) is proposed as an alternative to conventional OFDM with cyclic prefix (CP) for transmission over multi-path fading channels. Two typical features of the OFDM/OQAM modulation are the absence of a guard interval (GI) and the fact that the orthogonality property only holds in the real field and for a distortion-free channel. Thus, the classical channel estimation (CE) methods used for OFDM cannot be directly applied to OFDM/OQAM. Therefore, we study the transmission of an OFDM/OQAM signal through a time-varying multi-path channel, where each sub-channel is considered distortionless and the time domain channel equalization reduced to single-tap channel gain. We derive different CE methods, the first proposed method only requires the use of a pair of real pilots (POP). In the second method, denoted as interference approximation method (IAM), we show how the imaginary interference can be used to improve the CE quality. Several preamble variants of the IAM such as IAM-I (with imaginary pilots) and IAM-R (with real pilots) are also discussed. In the third method, by analyzing the noise distribution and correlation characteristics on each subcarrier in OFDM/OQAM systems we present the maximum likelihood based frequency domain averaging (ML-FDA) approach for CE. Finally, the performance results obtained for the transmission of an OFDM/OQAM signal through a standard known channel and Rayleigh fading channel using the POP method, two variants of IAM and ML-FDA method are compared with CP-OFDM.

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Title	:	*EXIT Chart Based Performance Analysis Of Fixed Point Implementation Of Turbo Codes*
Author(s)	:	*Sinha Prithwiraj*
Roll No	:	*13104105*
Supervisor(s)	:	*Vasudevan Kasturi*

Abstract:

Turbo codes have achieved near Shannon limit performance in communication over noisy channels. The EXtrinsic Information Transfer(EXIT) chart analysis is now an essential part of turbo code design and an alternative tool to the traditional BER/SER curve to evaluate its performance. In this thesis we perform EXIT chart analysis of different types of turbo codes namely, parallel concatenated, serially concatenated and also turbo code consisting of parallel concatenated non systematic convolutional codes. Moreover, keeping in mind the increasing necessity and importance of designing low power wireless sensor networks in a variety of civil and military applications, low power consuming, fixed point implementation of turbo codes has been considered and analyzed using the EXIT chart.

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Title	***:***	***Analytical Model for Information Propagation Speed in Highway Vehicular Networks***
Author(s)	***:***	***Ranyal Sachin Dev***
Roll No	***:***	***13104126***
Supervisor(s)	***:***	***SinghYatindra Nath***

Abstract:

VANETs (Vehicular Ad hoc Networks) are upcoming wireless network environment for Intelligent Transportation Systems (ITS). VANETs promise to enhance the road safety and travel comfort significantly in both highway and city scenarios. Message propagation, either for emergency or routine purposes, constitutes a major category of VANET applications and is particularly challenging in infrastructure-less vehicle to vehicle communication scenarios. In this thesis, we study the information propagation process in mobile ad hoc network formed by the vehicles which are distributed with exponential statistics on a highway. We derive the analytical model for the fundamental properties of the information propagation speed (IPS). Using the model, one can predict the impact on the Information Propagation Speed for various parameters such as radio range, vehicular traffic density and vehicular speed. The research provides useful guidelines on the design of vehicular ad hoc networks. Contribution to the work includes,the modelling of message propagation among vehicles on a highway with a delay tolerant network setting, taking into account the random distribution of distances between vehicles, the speed of vehicles and the radio range. The main objective has been to use the vehicles in different lanes with different velocity, to propagate messages more efficiently.

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Title	***:***	***QOS Analysis In Data Network: Stability, Reliability, QOS Invoke Rate Perspectives***
Author(s)	***:***	***Mishra Pankaj Kumar***
Roll No	***:***	***13104097***
Supervisor(s)	***:***	***Singh Yatindra Nath***

Abstract:

Services on a packet routing network like internet, demand Quality of Service (QoS) for a satisfying experience. QoS is a guarantee of service. It can be relatively stringent or non stringent. QoS comprises of bandwidth, delay, delay variation (jitter) and packet loss parameters. Now, there arises a question if QoS provisioning is always required in a network. The answer is non-affirmative. It depends upon the resource crunch conditions. One of the criteria is the load condition. As load condition increases, it causes resource crunch beyond a critical point. Up to this critical point, there is no need to worry about QoS. Provisioning of QoS becomes important above the critical load condition. Based on the load conditions, a network operation can be divided in two segments. First when the load conditions are in the range and QoS support is not required, and second when the load is such that QoS support mechanisms are must for the delivery of satisfying experience. The work in this thesis is in two parts covers these two segments of network operation. Firstly, for the situation when QoS provisioning becomes mandatory in a network, this thesis analyses the QoS issue in terms of two basic parameters: stability and reliability. Secondly, it finds out the critical load condition up to which QoS provisioning is not required in a network system. Stability covers the bandwidth and the delay, and reliability deals with the delay and the packet loss parameters. A network system is stable when number of packets remains bounded in the network while the system runs for arbitrary long period of time. It is reliable if every packet is delivered across the network in a bounded time. The stability and reliability contribute towards QoS in an overlapping manner. This work carries out the stability and reliability analysis of a packet routing network under the Adversarial Queuing Model (AQM). AQM represents a network system by three elements: the under lying Network Graph, the Adversary and the Queuing policy. An adversary is a hypothetical entity injecting packets in the network at some rate r. The rate of adversary determines the load condition. The queuing policy chosen is SP/FIFO (Strict Priority/First In First Out) scheduling policy, since it resembles the existing QoS scheduling approach in internet. A multiclass station and multiclass acyclic network with SP/FIFO policy is designed to bring out the stability and reliability results based on the rate conditions of the adversary. The work determines the conditions when two class single station network is stable but unreliable and further generalises it to multiclass. Thesis also derives the stability condition of two class two station acyclic network and generalises it to multiclass chain of stations. Further, it proposes two policies to avoid such unreliability in stability preserving manner. Lastly, the thesis work deals with the segment of network operation upto which resource crunch does not exist and the QoS provisioning is not required. First question it deals is that, if at all load conditions (rate of adversary) QoS provisioning is needed in the network system. The answer is no, it is not required till the resource crunch does not occur. Then, what is the critical load above which QoS provisioning needs to be invoked in a network system? The answer depends on the network type like cyclic or acyclic. Here, this critical load at which the QoS provisioning needs to be invoked is derived in terms of adversarial injection rate for an acyclic network based on QoS parameter of delay. This critical rate of adversary has been termed as QoS Invoke Rate. Thus, the thesis covers the two segments of the network operations by giving out stability and reliability of acyclic multiclass networks when resource crunch occurs and a QoS Invoke Rate for an acyclic network for the range of the network operation where resource crunch is not there.

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Title	***:***	***Conversion of Aspect ratios using a novel mirror setup***
Author(s)	***:***	***Gogineni Bhargava***
Roll No	***:***	***Y8127209***
Supervisor(s)	***:***	***Venkatesh K S***

Abstract:

Conversion of aspect ratios is sometimes required in signal processing, given the rigidity of sensor formats, and the high variability of user requirements. Until now, we had, at best, a certain number of fixed resolutions and aspect rations such as 3:4, 16:9, 16:10, 14:9 etc available for sensors. Applications had to willy nilly choose one of these and either adapt their requirements to what was available, or else use the sensor sub-optimally. We propose here a general design for optical arrangements which, along with a camera in a standard aspect ratio format, can solve the problem of transforming the cameras fixed aspect ratio into our choice of aspect ratio. For this, we devise a method/process which configures a simple mirror setup and a conventional camera pointed towards the mirror setup for obtaining strips of images at different distances from the camera setup. These images are individually and jointly processed to get a single (very) wide-angle image.

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Title	***:***	***Fault Tolerant Node Disjoint Multipath Routing In Manets***
Author(s)	***:***	***M Venkatesh***
Roll No	***:***	***13104072***
Supervisor(s)	***:***	***Singh Yatindra Nath***

Abstract:

A Mobile Adhoc Network (MANET) represents a collection of wireless mobile de- vices that can communicate with each other without the requirement of any pre ex- isting infrastructure via wireless links. Routing in MANETs is a difficult task since the nodes present in the network are mobile and the topology of such a network is prone to changes. A Routing protocol which can adapt to these topology changes is preferred to operate in MANETs. Adhoc On-demand Distance Vector routing proto- col (AODV) is one such routing protocol which establishes a single path for any given source-destination pair. If the single path between the source and destination breaks, then the source node needs to reinitiate a new path discovery process. Hence, single path routing does not support fault tolerance. In MANETs, multiple paths are desired since they can ensure fault tolerance. The multipaths can guarantee fault tolerance only if they are link disjoint or node disjoint. Link disjoint paths have no links in common, whereas Node disjoint paths have no nodes in common. Link disjoint paths ensure fault tolerance with respect to link fail- ures whereas Node disjoint paths ensure fault tolerance with regard to link failures as well as node failures. Additionally, Node disjoint paths can also aid in load sharing which can reduce congestion in the network. Hence, we prefer the formation of node disjoint multipaths for any given source - destination pair. In this thesis, we have proposed a node disjoint multipath algorithm based on AODV which can find node disjoint paths between any pair of source and destination in a single route discovery. We have simulated our proposed algorithm and compared it with respect to an existing multipath protocol known as Node Disjoint Multi Path- AODV (NDMP-AODV). Simulation results show that our proposed algorithm finds more number of node disjoint paths per route discovery cycle and needs lesser number of route discovery cycles for route maintenance as compared to NDMP-AODV.

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Title	:	*Papr Reduction In OFDM System By ZADOFF-CHU Transform*
Author(s)	:	*Chaudhry Ravinder K S*
Roll No	:	*13104120*
Supervisor(s)	:	*Vasudevan Kasturi*

Abstract:

The modern wireless communication era has seen the advent of many new technologies for meeting the ever increasing demand of high data rates and high performance at low costs. Orthogonal frequency division multiplexing (OFDM) is a multicarrier modulation technique popular primarily because of its high-speed data transmission, simplified digital implementation and effectiveness in combating the frequency selective fading channel. OFDM technique is widely used in wireless communication nowadays. High peak-to-average power ratio (PAPR) is one of the major drawbacks for OFDM systems. High PAPR degrades the efficiency of high power amplifier (HPA). Unfortunately HPA is the most expensive device in the RF module. According to the literature reduction of PAPR through precoding method (precoding matrix) is better than using the DFT matrix. This thesis is dedicated to the study of the Zadoff-Chu Transform for PAPR reduction. The Zadoff-Chu Transform is a symbol scrambling technique for PAPR reduction, which has a lower computational complexity when compared with other scrambling techniques such as SLM and PTS.

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Title	***:***	***Anthropological Location & Identity Authentication***
Author(s)	***:***	***Pratiher Sawon***
Roll No	***:***	***13104135***
Supervisor(s)	***:***	***K S Venkatesh&GuptaSumana***

Abstract:

In this work, we present different methods of authentication based on concepts borrowed from cultural anthropology. The methods discussed here explore the ap- plicability of anthropology in computer systems by focusing on emulating the inter- actions in our social and cultural sphere by means of computer algorithms. Most of the existing work on authentication deals with token based verification meth- ods, conventional shared information based authentication and/or physiological as well as behavioral biometrics. Our method uses a certain concept used by cultural anthropologists: This idea holds that conventions and practices followed and specific to a certain cultural community are completely opaque to non-members of that community. We apply this idea in our novel construction of an authentication system by treating the authorized and his computer as a cultural community of two individuals, and the unauthorized user becomes the outsider. Our authentication system introduces certain other innovations: one is the pro- vision of location authentication, by means of visual sensors to visually sense the immediate environment, and compare it against the trained data. This simultane- ously verifies the users identity as well, as the very sequence of execution of the location verification process requires knowledge shared with the system. Multiple themes have been developed and demonstrated as examples of how these ideas may be implemented, and to give a picture of the huge range of options and choices available.

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Title	***:***	***Performance Analysis of a Novel Radar CFAR Detector***
Author(s)	***:***	***Yadav Sher Bahadur***
Roll No	***:***	***13104139***
Supervisor(s)	***:***	***Vasudevan Kasturi***

Abstract:

Radar detection procedures involve the comparison of the received signal amplitude to a threshold. In order to obtain a constant false-alarm rate (CFAR), an adaptive threshold must be applied reflecting the local clutter situation. Their primary goal is to maintain the desired false alarm rate and to be invariant to changes in the clutter density function. This is achieved by adaptively estimating the clutter power based on a finite number of clutter samples within a processing window. To achieve this, a CFAR detector processes a finite set of range-Doppler samples within a reference window surrounding the cell under test and sets the threshold adaptively based on a local estimate of the total noise power. The CA-CFAR detector is optimal for detecting targets embedded in exponential clutter and noise of unknown power, utilizing maximum likelihood estimate of the noise power to set the adaptive threshold. The order statistic (OS) CFAR detector is robust in rejecting impulsive noise and preserving edges. The proposed novel CFAR detector combine the result of the cell averaging (CA) CFAR and OS-CFAR to get a better detection performance. In a homogeneous background, the mathematical models of the two new CFAR detectors are derived and their performance has been evaluated and compared with that of CA-CFAR and OS-CFAR.

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Title	***:***	***Performance of Channel Independent Precoder with and without Channel estimation for OFDM***
Author(s)	***:***	***Meshram Krunal***
Roll No	***:***	***13104071***
Supervisor(s)	***:***	***Vasudevan K***

Abstract:

Orthogonal Frequency Division Multiplexing (OFDM) provides an efficient means to mitigate Inter Symbol Interference (ISI) caused by the channel multipath spread and requires simple frequency domain channel equalization via the Fast Fourier Transform (FFT). However, in addition to the problem of large peak-to-average power ratio (PAPR), there is a necessity for accurate frequency synchronization. Channel coding is used to improve the diversity across frequency and time, and recently linear precoding and block spreading are introduced for OFDM systems to gain frequency diversity. The precoded data symbol modulated on a subcarrier is now a linear combination of the original data symbols and if any subcarrier experiences a deep fade, the original data symbols can still be recovered from the other subcarriers. Hence the system performance is improved due to increased diversity order. In our thesis, we study the diversity performance of different channel independent precoders with and without Channel Estimation for orthogonal frequency division multiplexed (OFDM) systems over fading channels. The design of precoders is based on the information redistribution of the input modulated symbols among the output precoded symbols. The proposed precoders decreases the variance of the instantaneous noise power at the receiver produced by channel variations. The employment of different interleavers together with precoding matrices allows different configurations of time-frequency diversity which can be easily adapted to the channel conditions. The size of precoding matrices does not depend on the number of data carriers in an OFDM symbol. The precoder is evaluated with a modified Zero Forcing (ZF) equalizer whose maximum gain is constrained by means of a clipping factor. Thus, the clipping factor limits the noise power transfer in the receiver de(pre)coding block in low SNR conditions. We also show the performance of precoder with comb-type pilot based channel estimation with Least Square (LS) and Minimum Mean Square Error (MMSE) estimates with optimum clipping.

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Title	***:***	***Low complexity OFDM based on GIPS-Transform with Reduced BER and PAPR***
Author(s)	***:***	***Rane Sahil***
Roll No	***:***	***13104117***
Supervisor(s)	***:***	***Vasudevan Kasturi***

Abstract:

The Gaussian Integer Perfect Sequence (GIPS) based transform for orthogonal frequency division multiplexing (OFDM) system has been proposed in the literature. The transform matrix is both unitary and circulant, with each column being a perfect Gaussian integer sequence containing just four non-zero elements of {±1,±j}. This significantly reduces the complexity at the transmitter. In addition, the dynamic range of the transmitted signal is much less than that of the traditional OFDM system and hence results in reduced peak-to average-power ratio (PAPR). However, the bit error rate (BER) remains unchanged compared to conventional precoded OFDM system. In this work, we have proposed a new random interleaver based system model using GIPS transform. The proposed approach is found to have a better BER performance than the GIPS-transform method, when MMSE equalizer is used, without affecting complexity and PAPR performance. A closed-form expression is derived for the BER in GIPS-OFDM under frequency-selective fading channels, for ZF and MMSE equalizers. Using the union bound on BER of linearly precoded OFDM system, we have derived an expression to show that BER performance of interleaver based system is better than the GIPS-OFDM. Our simulation results are also in agreement with the derived expression. We have shown the enhancement in the PAPR performance when partial transmit sequence (PTS) is used along with GIPS-OFDM. Our complexity analysis shows, that it is more beneficial in terms of complexity, to implement PTS with GIPS transform than with the conventional OFDM system.

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Title	:	*Algebraic Independence: Criteria and Structural Results over Diverse Fields*
Author(s)	:	*Pandey Anurag*
Roll No	:	*10327137*
Supervisor(s)	:	*Singh Yatindra Nath*

Abstract:

We consider the property of algebraic independence of elements over a field. This is a higher degree generalization of linear independence. Polynomials f1, . . . , fm ∈ F[x1, . . . , xn] are said to be algebraically dependent over the field F if there exists a non-zero polynomial A ∈ F[y1, . . . , ym] such that A(f1, . . . , fm) = 0. If no such polynomial exists, we say that f1, . . . , fm are algebraically independent. We consider the problem of testing whether a given set of polynomials is algebraically independent. The problem has an efficient (randomized polynomial time) algorithm based on the Jacobian criterion when the polynomials are given over a field of zero characteristic. However this criterion fails when the polynomials are over fields of positive characteristic. The best known algorithm for the positive characteristic case is due to the Witt-Jacobian criterion which puts the problem in the complexity class NP#P. The thesis aims to find alternative criteria and algorithms to test algebraic independence of polynomials. We propose a technique based on polynomial maps and other faithful transformations which in some special cases, gives a polynomial time algorithm for testing independence over fields of positive characteristic. We also give an alternative criterion for positive characteristic case based on the p-adic valuation of the Jacobian determinant. This reduces the problem of testing algebraic independence to checking if a rational function solution exists to a linear first order partial differential equation modulo a prime. We further prove using L¨uroth's theorem that two algebraically dependent polynomials over a field of positive characteristic can be lifted such that they become dependent over the rationals. This again gives a differential equation based criterion for testing independence over fields of positive characteristic. We also prove that the minimal annihilating polynomial of two supersparse polynomials over the rationals is sparse in most of the cases, giving as well the exact characterization of those cases. We further use this result to give an alternative randomized polynomial time algorithm for testing independence of two supersparse polynomials over the rationals. We finally give an efficient higher derivatives based Jacobian like criterion to test algebraic independence in a special case over F2.

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Title	:	*Interference Alignment With Channel Uncertainity And Estimated Channel Through Kalman Filter*
Author(s)	:	*Kumar Manoj*
Roll No	:	*13104077*
Supervisor(s)	:	*Sharma Govind*

Abstract:

Interference Alignment (IA) is a promising technique to mitigate the multiuser interference completely but it needs perfect channel state information (CSI) at the transmitter end for designing of the precoding matrix. In frequency division duplex (FDD) system, CSI at the receiver is fed-back to the transmitter for use in IA algorithm. Since perfect CSI is practically unavailable, in this thesis the following aspects of imperfect CSI have been studied: Impact of additive channel uncertainity and impact of channel estimated by Kalman filter on sum rate. Abstract Since eliminating the interference from all the users is not necessary because some user's interference have very less impact on the sum rate due to the large path loss. The number of users may lead to the signalling overhead and feasibility constraint. To overcome with this problem, clustering of users into disjoint user is done. Designing of cluster is such that in between clusters the interference should be very small. In clustered IA system, estimation of channel is done through Kalman filter and see the changes in sum rate.

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Title	:	*Precoded Superimposed Pilot For Channel Estimation In Rayleigh And Rician Fading Channels: Uplink Massive Mimo*
Author(s)	:	*Jain Anmol*
Roll No	:	*13104017*
Supervisor(s)	:	*Sharma Govind*

Abstract:

Massive MIMO (multiple-input multiple-output) is a multiuser MIMO technology where each base station (BS) is equipped with an array of large number of antennas. For effective operation in multicell multiuser Massive MIMO system, BS requires accurate channel state information. But large numbers of users and limited coherence time introduces problem of pilot contamination which deteriorates channel estimation. This thesis introduces precoded superimposed pilot scheme for channel estimation and data detection in uplink transmission. We derive expressions for mean square error, self-interference, cross-interference and sum-rate in both Rayleigh and Rician fading channels. Simulation results confirm that the proposed scheme reduces self-interference and increases sum-rate compared to conventional superimposed pilot scheme.

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Title	:	*Explorations Of Multidimensional Modulo Tic Tac Toe*
Author(s)	:	*Tiwari Asutosh*
Roll No	:	*Y9227152*
Supervisor(s)	:	*Venkatesh K S*

Abstract:

In this Thesis,we would introduce readers to variants of the common game Tic TacToe,includingModuloTicTacToeandReverseModuloTicTacToe. In anormalTicTacToegameplayedona3x3boardaconsecutivesetofthree pointsisconsideredtobeasuccess.Fora3x3board,n=3andk=2.Wewillbe discussing totalpossiblenumberofsuccessesfordi erentsetsof(n,k).Wewould see possiblerelationshipsbetweennandkandtotalnumberofsuccesses.Wewould beobservingsamerelationshipsforModuloTicTacToe.Wewouldobservesame cases forReverseModuloTicTacToeaswell.

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Title	***:***	***Shape reconstruction for ISAR imaging***
Author(s)	***:***	***Papanna Jayaprakash Koppa***
Roll No	***:***	***13104058***
Supervisor(s)	***:***	***Naik Naren***

Abstract:

Inverse Synthetic Aperture Radar (ISAR) imaging is a technique used for reconstructing radar images of targets. Modern high resolution radars are equipped with the hardware needed for performing ISAR imaging. ISAR images are obtained by signal processing carried out both online/offl ine are a graphical representation of the target reflectivity function. The use of radar images will aid Automatic Target Recognition (ATR) systems in identi cation and classi cation of the targets of interest. The performance of ATR systems can be improved by using radar images of the target. In the present work, the problem of direct shape reconstruction of an object using ISAR data is considered. At first, the linear-static case is considered in which all the scattering centers of the objects are estimated and then the shape is reconstructed. The problem of direct shape reconstruction is considered next and the problem is modeled as nonlinear least squares problem. The boundary of the object is represented using closed cubic B- spline curve, whose control points can be changed individually. The object is modeled using the concept of zero level sets representation and signed distance function. The Frechet derivatives are computed and veri ed as part of the minimization of the nonlinear objective function. A nonlinear-iterative reconstruction algorithm is applied on ISAR data. Levenberg-Marquardt algorithm is implemented to solve the underlying non linear least squares problem and the unknown control points are estimated. For, the linear static case , the reconstruction is achieved for an aircraft type shape with noise added in the measurement data. The output is demonstrated via numerical simulation. For the, non linear static case, the Frechet derivative is computed and verifi ed with the finite diff erence method and preliminary reconstructions of basic shapes are achieved. The proposed algorithm serves as an aid in automating the process of target recognition in military systems.

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Title	***:***	***Marker Less Hand Detection And Gesture Recognition From 2d Sensor Data***
Author(s)	***:***	***Bolluru Praveen***
Roll No	***:***	***13104031***
Supervisor(s)	***:***	***K S Venkatesh***

Abstract:

Hand gesture recognition systems can be used for human-computer interaction (HCI). The use of hand gestures provides an attractive alternative to cumbersome interface devices for HCI. Proper hand segmentation from the background and other body parts of the video is the primary requirement for the design of a hand-gesture based application. This thesis discusses about continuous hand gesture recognition. It reports hand detection as well as segmentation algorithms which are based on skin colour estimated from the face of the human agent i.e. free hand detection.The face of human is detected using Viola/Jones Face Detector. We used face detector not only to remove the face also we estimated skin colour range for the human agent. In our approach, video frames are captured from a low cost webcam (camera) for vision based gesture recognition technique. The features of hand skin color in two different colour spaces, viz. the YCbCr and HSV color space are jointly used to detect the hand. Further, the fingertips of the hand are used to form a distinctive constellation of points, which is highly specific to the human hand and cannot be easily encountered in other objects. This constellation yields the position and orientation of the hand and fingertips, thus enabling us to design various gestures. The algorithm has been used to design a few specific gestures. This involves tracking the change in position of the hand or change in its orientation. Gestures have also been designed for two hands used simultaneously, keeping a track of their positions with respect to each other. The system works in real time. The software used for the project is Computer Vision in Microsoft Visual Studio using C and C++

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Title	***:***	***Estiimation and Cancellation of Lens Flare***
Author(s)	***:***	***Tundulwar Aditya***
Roll No	***:***	***13104008***
Supervisor(s)	***:***	***Venkatesh K S***

Abstract:

In this work, we focus on one of the most common disturbances in images, lens flare or unwanted light scattering or reflection inside the camera lens system. This stray light in an image is unwanted in professional photography, though some professionals have become used to treating it as an aesthetic factor. Recently developed camera lens systems are more prone to this effect as they use combinations consisting of multiple lenses. We also explain how reflection lens flare appears around the flare line, particularly joining optical center and light source. Positional symmetry between lens flare position and light source is explained with linear regression model. The radial symmetry of camera lens system is taken into consideration to estimate the lens flare for a captured image. We also have shown that important properties of camera lens system can be found out using reflection lens flare such as optical center of camera and shape of aperture of camera. Location of optical center in captured image also gives some information about lens system of camera and sensor plane of camera i.e. CCD array.

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Title	***:***	***Precoding with time-domain feedback in MIMO-OFDM systems***
Author(s)	***:***	***C Laxmikanth Rao***
Roll No	***:***	***13104032***
Supervisor(s)	***:***	***Vasudevan Kasturi***

Abstract:

Precoding exploits channel state information (CSI) at the transmitter to enhance the performance of the system. For most practical systems, channel state information is not readily available. Hence, CSI is conveyed through a feedback link from the receiver to the transmitter. In such systems, limited feedback resources, associated feedback delays, reduce the usefulness of channel state information at transmitter (CSIT). Aiming at reducing the feedback overhead, vector codebooks that are known both to the receiver and transmitter are designed. The receiver estimates the channel and chooses a precoder matrix based on a performance criteria from a _nite set, and sends the index of the matrix to the transmitter using limited number of bits. For MIMO-OFDM systems, precoder matrices have to be designed for every subcarrier increasing the feedback overhead linearly with the number of subcarriers. To overcome this clustering, interpolation schemes are proposed which exploits the correlation of adjacent subchannels in OFDM. In this work, we show for slowly time varying channels, feedback of quantized channel taps to the transmitter performs better than limited feedback precoding for a given feedback overhead. BER simulations validate the performance of limited feedback precoding and time domain quantized channel feedback precoding with the linear MMSE receiver.

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Title	***:***	***On History Assisted Spectrum Sensing for Cognitive Radio***
Author(s)	***:***	***Darmwal Yogesh***
Roll No	***:***	***13104162***
Supervisor(s)	***:***	***Banerjee Adrish***

Abstract:

Cognitive radio(CR) is an intelligent communication system that can solve spectrum scarcity problem. It allows secondary user to access underutilized radio spectrum in non-interfering manner. To access the spectrum, cognitive radio needs to sense its RF -environment to know whether the band is free or not. Therefore spectrum sensing is an important task of CR. A number of spectrum sensing techniques have been proposed in the literature to find out the spectrum opportunities in the temporal domain. However most of them are periodic in nature. A periodic spectrum sensing technique is one which sense the channel periodically after every τ seconds. With the help of learning capability of cognitive radio, an aperiodic spectrum sensing technique can be proposed. In aperiodic sensing technique, cognitive radio learns the pattern of primary user occupancy behavior and based on the learned behavior, it can predict future behavior of primary user. We need to sense the channel only when we are not confident about the state of channel. Thus aperiodic spectrum sensing improves spectrum utilization by minimizing wastage of resources. In this work, we present a new spectrum sensing technique, in which prediction of future state of PU (primary user) is used to identify time instances where sensing is required and for all other time instances we use prediction results to know the state of the channel.We show through simulations that the proposed method method works better than periodic spectrum sensing.

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Title	***:***	***On Techniques to Detect Malicious Users in Cooperative Spectrum Sensing***
Author(s)	***:***	***Patra Swarup Suman***
Roll No	***:***	***13104148***
Supervisor(s)	***:***	***Banerjee Adrish***

Abstract:

Increasing use of wireless technology has lead to greater demand for radio spectrum. As spectrum is a scarce resource, it needs to be regulated and available radio spectrum usage should be optimized. Cognitive radio is an intelligent wireless system that opportunistically access the channel and increases the efficiency of spectrum utilization. However, the cognitive radio's spectrum sensing performance degrades severely when few malicious users are present. The malicious users report false information to the fusion center thereby causing the fusion center to make a false spectrum sensing decision. In this thesis we propose a proximity based outlier detection method known as k-nearest neighbor approach, that does not require an estimate of the number of outliers. We have also considered the effect of secondary users (cognitive users) position relative to primary users (licensed users) on system's performance. We have also proposed a goodness-of-fit based cooperative spectrum sensing method using Anderson-Darling test (AD) and Kolmogorov-Smirnov (KS) test. This method uses the empirical CDF of the received energy values and compare it with the theoretical distribution of each hypothesis. Then we use Dempster-Shafer theory (DS) to combine the results of both AD test and KS test. Proposed tests outperform tests based on single goodness of fit tests.

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Title	:	*Image Binarization of Historical Degraded Document Images*
Author(s)	:	*Chirag*
Roll No	:	*13104033*
Supervisor(s)	:	*GuptaSumana&Venkatesh K S*

Abstract:

Document image binarization in the presence of di erent types of degradations is a challenging task.Binarization is the preprocessing step required to separate out text region from non-text region in a document.It is an important step in document analysis as it a ects the performance of Optical Character Recognition(OCR). In this thesis we present a novel method of binarization of historical docu- ment images a ected by typical degradations such as stain,ink-bleeding and non-uniform background.The method can handle document images a ected by multiple defects.The method is based on choice of appropriate thresholding techniques.The proposed method is tested on di erent degraded data sets and its performance is compared with existing methods in terms of F-Measure, Misclassi cation Penalty Metric(MPM) and Peak Signal to Noise Ratio(PSNR).

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Title	***:***	***Utilisation of heat generated in high concentration 2D photovoltaic systems by thermoelectric converters***
Author(s)	***:***	***Goswami Bhanprakash***
Roll No	***:***	***13104027***
Supervisor(s)	***:***	***AnandRaghubir Singh&Kumar Iyer S Sunder***

Abstract:

Concentrated Photovoltaic technology has potential to produce electricity efficiently and cost effectively. As a part of this thesis work, a 1.8 kWp high-concentration 2D photovoltaic system (CPV) located in the Solar Energy Research Enclave (SERE), IIT Kanpur has been studied with an aim to improve its performance. For a start, the devices were spruced up by placing and ensuring that the triple-junction solar cells at the focus of the concentrators. The connecting wires were shielded by aluminium sheets so that wires were protected from an off focus beams between the time the system moves to face the Sun. Due to resource constraints, other improvements were not carried out for the time being. All the same, the efficiency of the system increased to about 11% from less than 5% at the start of the project. Due to the high concentration (1000 X) of solar irradiation in the CPV systems, a large amount of heat is dissipated in the solar cells. This heat is supposed to be transferred to the environment by natural convection using heat sinks or by active cooling with the help of fluid (water) circulation. As a part of this thesis work, the heat developed in the CPV systems was converted to the electricity using thermoelectric converters. The CPV system and the thermoelectric generator were studied independently and in an integrated form for their voltage-current-temperature characteristics. To dissipate heat and create temperature difference on two sides of the thermoelectric generator, various topologies using static and forced air and water have been tested. As expected, forced water created larger temperature difference and give better thermoelectric generation. To utilise the heat generated in the CPV system, two designs were explored. In the first design, the thermoelectric generator (TEG) was placed inside the CPV module between the solar cell and the heat sink. In the second design the TEG was placed on the metallic body at the back of the CPV module. It was found that, although first design resulted in better thermoelectric generation, due to low heat transfer through the TEG, the temperature at the solar cell increased more and deteriorates its PV performance. The overall efficiency when using this design actually decreased to 9.69% for air cooling and to only 10.79% with water cooling. In the second design, thermoelectric generation was found less compared to the first design, but in this design CPV power generation was not getting affected as much. The overall efficiency marginally increased to 11.04% for air cooling and 11.12% for water cooling with this design. Further optimisation of design should help extract more power by combining TEG and the CPV.

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Title	:	*Thermal Resistance modeling in FINFET and FDSOI transistors*
Author(s)	:	*Kompala Bala Krishna*
Roll No	:	*13104069*
Supervisor(s)	:	*Chauhan Yogesh Singh*

Abstract:

While device dimensions continue to shrink down to the 16-nm node, self-heating e ects emerge as a pressing problem, detrimental to leakage current and mobility in both Fully Depleted Silicon On Insulator (FDSOI) transistors and Fin Field E ect Transistors (FinFET). This work examines the heat dissipation paths in the context of nanoscale transistors and propose models for thermal resistance variation in both FDSOI and FinFET transistors. In this work, 3-D FDSOI device simulations with variation in both channel length and channel width are done using Sentaurus Technology Computer Aided Design (TCAD). From these 3-D device simulations, we see that thermal resistance increases with reduction in channel length. A compact model for geometrically scalable ther- mal resistance in FDSOI transistors is developed after extensive analysis of 3-D TCAD simulation data at di erent ambient temperatures. This model is tested with industry standard BSIM-IMG model and shows excellent agreement with the experimental data. In addition, this work also includes the simulations of 3-D FinFET device with variation in the number of ns (Nfin), shape of ns and n pitch (Fpitch) using Sen- tuarus Process. It is investigated that thermal resistance has nonlinear dependency on Nfin and Fpitch. A model for thermal resistance behavior correctly with Nfin and Fpitch variation is proposed. The proposed model is tested with industry standard BSIM-CMG model and has shown good agreement with the experimental data and TCAD simulations.

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Title	***:***	***Simulatioin And Modelling Of Organic Light Emitting Diode***
Author(s)	***:***	***Saraba Epili Raja Kirana Saraba***
Roll No	***:***	***13104044***
Supervisor(s)	***:***	***Mazhari Baquer***

Abstract:

Organic light-emitting diodes (OLEDs) are being actively developed for flat panel active matrix displays and solid state lighting due to their unique properties such as simple fabrication process, wide viewing angle, thin and flexible form factors and potential low cost. The process of light emission is based on injection and recombination of electrons and holes from electrodes into a stack of organic layers under the influence of applied voltage. Of the various factors, electron and hole current balance is prerequisite to achieve OLED efficiency. Due to widely different electron and hole mobility in organic semiconductors, current balance is normally poor and has to be improved through use of specialized techniques. In this thesis, two techniques namely use of a bi-layer OLED structure and addition of dopants that act as a trap for one carrier are investigated in detail. In a bi-layer OLED, energy offset at the heterostructure plays a key role in achieving current balance. To investigate the impact of energy offset on current transport, current in a hole-only device is studied in detail. An analytical model is developed which correctly predicts an injection limited current behavior with a cubic dependence on both voltage and layer thicknesses and an exponential dependence on hole barrier at organic-organic interface. The use of dopants acting as traps for the more mobile carrier was investigated in detail. It is shown that through judicious choice of trap energy and concentration, mobility of one carrier can be selectively decreased while keeping mobility of other carrier unchanged. Current balance and a broad recombination zone spread over the entire device could be achieved. However, the characteristics were sensitive to trap characteristics and initial mobility values.

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Title	:	*Study of suitability of four di-keto-pyrrolo-pyrrole derivatives for active layers in organic solar cell*
Author(s)	:	*Saurav Kumar*
Roll No	:	*10327363*
Supervisor(s)	:	*Iyer S Sundar Kumar*

Abstract:

Development of high efficiency organic solar cells is an actively pursued area in current research. This requires synthesis of new materials which have enhanced mobility and high absorption coefficient in visible region. Di-keto-pyrrolo-pyrrole is being investigated in this direction because of its good electrical and optical properties. This research work studies the applicability of four molecules based on Di-keto-pyrrolo-pyrrole derivatives synthesized by Dr. Somanathan's group at CLRI, Chennai. These molecules have a broad spectrum with high absorption coefficient in visible region which makes them promising for solar cell applications. Also, these materials have band gap around 1.5eV which is very close to Shockley–Queisser optimal band gap for maximum attainable efficiency of solar cells. Experiments for mobility measurements were performed by making hole only devices with PEDOT:PSS and gold as injecting electrodes. Single layer devices were fabricated by spin coating using chloroform as solvent. Mobility of these materials was observed to be of the order of 10-5 cm2 V-1s-1. It was noted that addition of small amount of diiodooctane to the solvent improved device consistency and increased the mobility by a factor of almost 5. Finally, two types of solar cells were made, first having bulk-heterojunction architecture and another with bilayer architecture. Bilayer devices were recorded to be more efficient for some molecules, while bulk-heterojunction structure showed more efficiency for others. Efficiency of these molecules was increased by orders of magnitude upon addition of diiodooctane in chloroform in case of bulk-heterojunction solar cells, however, bilayer cells had mixed behavior. During the course of experimental work done for this thesis, the peak efficiency registered was 0.2% in bulk-heterojunction solar cell with one of the four molecules being worked upon

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Title	***:***	***Extraction and modeling of threshold voltage in organic thin film transistors***
Author(s)	***:***	***Tiwari Swati***
Roll No	***:***	***10327756***
Supervisor(s)	***:***	***Mazhari Baquer***

Abstract:

The field of organic electronics has been drawing attention from researchers around the world for many years. Organic thin film transistors (OTFTs) have potential for development of active matrix displays, RFID tags, sensors and various other applications. To realize large scale organic electronics circuits, availability of a compact model of an OTFT becomes a key requirement. The rigorousness of compact modeling strongly relies on input parameters such as charge carrier mobility, contact resistance and threshold voltage. Threshold voltage is very important parameter for device modeling and circuit design using OTFTs. In this thesis work, threshold voltage parameter of OTFTs has been studied in detail. We have compared five different methods for V_T extraction on transfer characteristics of an OTFT, simulated on a Silvaco atlas. These five methods are Extrapolation in Linear Region (ELR), GMLE, Ratio method, VX method and GV method. We have analyzed the effect of including gate field dependent mobility model, interface traps and parasitic series resistance present in OTFTs on all above mentioned V_T extraction methods. We have also developed an analytical expression for threshold voltage based on assessment of surface potential for accumulation mode OTFTs. Our model provides a way to calculate surface potential based on the accumulated charges at semiconductor-insulator interface. We have used the basic fact that accumulation charge density follows exponential dependence on applied gate bias in sub-threshold regime and power law at higher biases. The results from the analytical expression are in close agreement with simulations. The simulated results are obtained by applying ELR and VX methods on I(DS)-V(GS) characteristics

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Title	***:***	***Analysis of photo-response of top-contact OTFT***
Author(s)	***:***	***Kumari Smriti***
Roll No	***:***	***10327718***
Supervisor(s)	***:***	***Mazhari Baquer***

Abstract:

Organic thin film devices are being actively developed due to the potential for implementing low cost flexible electronic systems using mass printing techniques. An organic photo-transistor combines the switching and amplifying property of a transistor with the light sensing capabilities of a photo detector thereby offering a device that can exhibit higher sensitivity and benefit from a simplified fabrication process. Although, the optical response of organic thin film transistors has been widely reported, there has been no systematic investigation of the detailed mechanism underlying the photo-response in these devices. This thesis uses 2D device simulations to investigate in detail the different possible mechanisms that can give rise to photo-sensitivity in a top contact organic thin film transistor. For devices, consisting of a single active semiconductor layer, the breakup of photo-generated excitons constitutes a key bottleneck especially when applied voltage is low in the linear mode of operation. In this case electric fields present are insufficient to break the excitons and photo-response is poor. In the saturation mode, when applied drain voltage is large and good source injecting contacts are used, a large field forms within the pinch-off region next to drain and exciton breakup occurs and photo-response is strong. It is shown that current under illumination increases due to effective modulation of hole channel length (p-type device) and formation of an electron channel. Electron channel can also be formed in dark by aligning work-function of drain electrode with the LUMO of semi-conductor. It was also noted that upon illumination current is not limited near oxide-semiconductor interface but starts spreading in the bulk. The effects of changing electron mobility, excitonic parameters and applied voltages are reported in detail. It was found that lower magnitude of gate voltage is better suited if one desires high sensitivity towards light.

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Title	***:***	***Study of suitability of four imidazolin-5-one derivatives for active layers in organic solar cells***
Author(s)	***:***	***Gupta Raghav***
Roll No	***:***	***10327553***
Supervisor(s)	***:***	***Iyer S Sundar Kumar***

Abstract:

New organic compounds are being actively developed for applications in solar cells owing to the high absorption coefficients and low processing costs. In this respect, the derivatives of the main chromophore of the highly fluorescent "Green and Red Fluorescent Proteins (GFP \& RFP)", imidazolin-5-ones, appear promising candidates owing to their excellent optical and electrical properties. This thesis investigates four such derivatives of imidazolin-5-one for organic solar cell applications. Wet processing with chloroform as the main solvent was used as the primary method to fabricate thin films and devices as opposed to most of the previous work done on imidazolin-5-ones where thermal evaporation was used. Absorption studies revealed that these molecules have high absorption coefficients in the blue-green region of the spectrum. Profilometry studies were conducted to study the roughness of the films. The electrical properties of the molecules were investigated by fabricating hole only devices with gold as the cathode. It was found that the molecules have mobility values that are orders of magnitude higher those of the previously reported molecules 2.1 x 10-4 cm2 V-1 s-1 as compared to 2.9 10-7 cm2 V-1 s-1 reported previously. Finally single layer devices and bulk heterojunction solar cells (with PCBM acceptor) were fabricated to study the photo-voltaic effect in the molecules. The device structure was optimized by testing two solvent combinations and two different hole transport layers. Peak efficiency of 0.024% was obtained in (Z)-4-(4-methoxybenzylidene)-1-methyl-2-((1E,3E)-4-phenylbuta-1,3-dienyl)-1H-imidazol-5(4H)-one (M2)-PCBM (1:1) bulk heterojunction solar cells of with PEDOT:PSS as the hole transport Layer.

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Title	***:***	***Effect of annealing poly 3-hexylthiophene layers in the presence of pulsed electric field***
Author(s)	***:***	***Gangwar Anshik***
Roll No	***:***	***10327119***
Supervisor(s)	***:***	***Iyer S Sundar Kumar***

Abstract:

Organic solar cells (OSC) have shown the potential to feed the ceaselessly soaring power demands of our society. The processing steps for fabrication of OSCs are much simpler, cost effective and energy efficient compared to conventional silicon solar cells. Hence, a lot of research interest is being taken to improve the performance of OSCs. Poly(3-hexylthiophene-2,5-diyl) (P3HT), now a days, is one of the most widely used donor material in OSCs. The thesis presents a comparative study of morphological and electronic properties of P3HT films annealed in the presence of pulsed electric field of 2000 Vcm-1 at several duty cycles and different frequencies. For comparison, conventionally annealed films and films annealed in the presence of a constant electric field of 2000 Vcm-1 were used as reference samples. X-ray diffraction (XRD) measurements were performed to understand the variation in crystal sizes of films. Analysis of XRD data confirms the increase in crystal size with the increase in duty cycle for each frequency. Current density-voltage (J - V) data in the dark for single layer P3HT devices was fitted to field dependent mobility J - V model at higher biases in space charge limited current region to estimate zero field mobility (μ0) of P3HT films annealed in the presence of different electric fields. The extracted mobility follows the same pattern as observed for crystal size. More than 15% increase in zero bias mobility is observed with pulsed electric field at 90% duty cycle and 100mHz frequency than the conventionally annealed reference samples.

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Title	***:***	***Oscillator And Amplifier Circuits Based On Single Layer Organic Devices***
Author(s)	***:***	***Gajbhare Sandeep Sanjayrao***
Roll No	***:***	***13104045***
Supervisor(s)	***:***	***Mazhari Baquer***

Abstract:

The field of organic semiconductor based electronics has seen significant and unprecedented progress in the past decade. Low-cost, less energy-intensive and high-throughput production, implementation on flexible and non-planar surfaces, novel applications, as well as the potential to move to more environmentally friendly electronics makes this technology particularly attractive. A wide range of applications of organic electronics are being currently explored, including displays, lighting, solar cells, printed RFID tags and disposable low-cost sensors. In this work also we will explore the use of the organic single layer device in many oscillators and analog amplifier. The simplest organic devices using pentacene as single layer of semiconductor were fabricated and characterized to create a device model. The oscillator and amplifier circuits were designed with the replacement of the linear passive resistors with the non-linear single layer organic device models and the extracted results from these circuits are compared with the conventional resistor based oscillator and amplifier. The effect of the non-linearity of I-V of the single layer organic device on stability and output waveforms of the oscillators were analyzed. Whereas in common emitter amplifier the effect of non-linearity of device is analyzed in terms of change in amplifier gain, harmonic distortion, etc. The aim is to replace the resistor with the single layer organic device and analyze the behavior of the analog circuits.

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Title	***:***	***Compact Modelling Approach For Organic Thin Film Transistors***
Author(s)	***:***	***Upadhyay Aditya***
Roll No	***:***	***13104009***
Supervisor(s)	***:***	***Mazhari Baquer***

Abstract:

Organic Thin film transistor (TFT) based flexible and printable electronics is a promising area. Recent advances in fabrication process for Organic TFTs have shown consistent improvement over the years. Accurate and physical simulations of Organic TFTs are critical for evaluating the performance of discrete devices and design of complex circuits. TCAD simulation provide valuable insight into the physics and operation of Organic TFT, however simulations of large circuits based on Organic TFTs are very expensive and slow in TCAD. Compact model with sufficient accuracy is required for simulation of large circuits based on Organic TFTs. This Thesis presents a modelling approach for Organic TFT by including physical effects like gate voltage dependence of mobility and exponential density of states and defects in a surface potential based compact model. Computational efficiency is achieved by developing analytical expression for surface potential. Model's performance is compared with the data from ATLAS, SILVACO simulations and a good match is achieved in simulated results.

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Title	***:***	***Time Dependent Degradation Study of Performance of P3HT:PC60BM and PTB7:PC70BM Based Organic Solar Cell Devices***
Author(s)	***:***	***Yadav Jyoti***
Roll No	***:***	***13104062***
Supervisor(s)	***:***	***Mazhari Baquer***

Abstract:

Solar energy is a very compelling source for fulfilling the energy requirements of our planet. There are many PV technologies such as Silicon based solar cells, GaAs based solar cells which are commercially produced but their complete potential has remained unfulfilled due to higher cost of electricity produced by these panels. Among new technologies, organic solar cells have potential to succeed as a future PV technology due to its potentially environment friendly nature and low cost of materials involved. Moreover, these devices offer advantages of flexibility and conformability on a wide variety of surfaces and hence offering a huge application domain. However, poor stability of organic solar cells in ambient conditions is a big impediment to achieve these goals. Moreover, analysis of stability requires time dependent studies. Stability of organic solar cells can be improved by use of encapsulation methods and the conventional one is to use the glass based encapsulation. Whilst this method provides excellent impermeability to the diffusion of oxygen and moisture into the device, high costs and rigidity associated with glass is in contrast to the purpose of organic solar cells in many ways, in particular flexibility and low cost using roll to roll processing methods. Hence it would be desirable to develop a thin film based encapsulation which can be flexible as well as should be possible to be integrated with device processing whilst providing protection equivalent to glass. In this work, we have carried fabrication and characterization of two bulk heterojunction devices: one based on the blend of well established material system P3HT:PC60BM and another using PTB7:PC70BM. We have carried out time dependent degradation studies on these devices and our results suggested that the device based on PTB7:PC70BM degrade much quicker than the devices using P3HT:PC60BM. We further carried our studies on P3HT:PC60BM by encapsulating them with a thin film of thermally evaporable oxide MoO3 using various combinations. However results suggested that MoO3 does not improve the device stability and that there is a need to investigate more materials which can be used as thin film encapsulant.

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Title	***:***	***A Truly Passive Pixel Image Sensor Array***
Author(s)	***:***	***Rituraj Rituraj***
Roll No	***:***	***10327605***
Supervisor(s)	***:***	***Mazhari Baquer***

Abstract:

Photodiodes are the most common choice for image sensing applications. In a large sensor matrix generally transistors are also required along with the photodiode in each pixel. The basic purpose of the transistor is to act as a switch to reduce crosstalk or interference from other unselected pixels. In an active matrix sensor network, the pixel circuitry could be used for various other operations besides switching. The pixel circuit can be a simple source follower amplifier in a 3-T active pixel sensor or as complex as an ADC (Analog to Digital Converter) in a digital pixel sensor requiring tens of transistors. These added functionalities come at a cost. The fill factor (fraction of total pixel area available for photodiodes) becomes small. Also the device fabrication becomes more complex increasing the processing cost. This might be necessary for high end applications but for many other noise insensitive applications a simple passive matrix sensor is the cost effective solution. Through this work we propose and demonstrate through simulations and experiment two novel photo sensor devices having inherent switching characteristics when biased in a certain region and thus making the use of in-pixel transistor for switching unnecessary. The resulting sensor matrix has a very simple structure, ideal fill factor, could achieve high spatial resolution and is very easy to fabricate. We have realized the device using organic materials which are known to have superior optical properties. This also has an added advantage of being low cost, requires simple processing steps and could be done on flexible substrates as well. Besides its use as a camera, the device could be used for developing a cheap, flexible and portable image scanner as well. The large area scanner would no longer require mechanically moving parts for scanning as is the case with conventional scanners.

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Title	***:***	***Effect of processing asymmetries on a-IGZO TFT characteristics and OLED pixel driver circuits***
Author(s)	***:***	***Chaudhary Kavita***
Roll No	***:***	***13104066***
Supervisor(s)	***:***	***Mazhari Baquer***

Abstract:

Indium-Gallium-Zinc-Oxide (IGZO) thin film transistor is one of the most popular area of research due to its higher mobility in comparison to convectional silicon thin film transistor. Now-a-days most of the industries are using inverted-staggered bottom gated etch-stop (ES) TFT structure of -IGZO. In this structure, generally there is symmetrical overlap between source/drain contact and gate contact. But these TFTs has very small channel length about 5 m to 10 m, due to which during fabrication source and drain overlap may slightly differ from their exact position and result in unsymmetrical overlap structure. These source/drain overlap asymmetries affect the electron path and consequently changing the electrical properties of -IGZO TFT for example parasitic resistance, drain current, threshold voltage etc. Currently -IGZO TFTs are used as backplane in display technologies in both OLED (organic light emitting diode) and LCD (Liquid Crystal displays) pixel driver circuit. Change in properties of the TFT device will also affect the operation of OLED. It is necessary to understand the characteristics of these TFTs thus simulate the -IGZO TFT with different overlap errors which occur during the fabrication of -IGZO TFT, and model the effective length and parasitic resistance and other electrical properties such as threshold voltage and sub-threshold swing. In this thesis -IGZO TFT device with same channel length but varying source/drain overlap is studied to investigate the exact effect of overlap on electron path and channel of the TFT device. The simulated results are further examined for device electrical properties. Later the spice simulation of AMOLED pixel circuit is done to analyze the operation of OLED pixel circuit like charging, discharging and switching.

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Title	***:***	***Correlation between Dark & Light Characteristics of Bulk Hetero-Junction Organic Photo-Voltaic Cells***
Author(s)	***:***	***Imamuddin Mohammad***
Roll No	***:***	***13104079***
Supervisor(s)	***:***	***Mazhari Baquer***

Abstract:

Environmental crisis and concerns about energy security are fueling the push for solar energy. Organic photovoltaics (OPVs) offer an alternative for harnessing solar energy in feasible and potentially low-cost manner. However, OPVs are suffering from low efficiency and instability compared to conventional inorganic silicon solar cells. Fill factor and open circuit voltage are the solar cell parameters that affect the solar cell efficiency directly. This thesis focuses on the understanding of fill factor and open circuit voltage from the OPV perspective and their correlation with other OPV parameters. In order to evaluate OPV parameters, inverted architecture ITO/ZnO/P3HT: PCBM/MoO3/Ag OPV devices are fabricated and characterized under dark and illumination. Various OPV parameters have been extracted from dark and light I-V characteristics. Due to field dependent polaron pair dissociation in OPV, shunt and series resistance model needs to be revisited. Simulation results of the OPV device show that the two parasitic resistances are not able to describe fill factor completely. Two new fill-factor (FF) like parameters, fill factor dark (FFD) and fill factor light (FFL), dependent on dark and photo-generated current respectively, are used to explicitly reveal the impact of each current component on fill factor. Correlation between fill factor, open circuit voltage, efficiency and Jd(Voc)/Jsc, are also observed. Differential function G(V) of dark current characteristic is employed to estimate the open circuit voltage of the OPV devices.

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Title	:	*A Study of Performance of Dual-Metal Gate Double-Gate TFETs (DMG-DGTFETs) and Development of a new Surface Potential based Drain Current Model*
Author(s)	:	*Prabhat Vishwa*
Roll No	:	*13104159*
Supervisor(s)	:	*Dutta Aloke*

Abstract:

A detailed study of the Dual-Metal Gate(DMG) Double-Gate Tunneling Field Effect Transistors (DGTFETs) is presented here. Simultaneous variation of tunneling and auxiliary gate work functions is shown to improve the current ratio between the ON and OFF states (ION/IOFF ratio) and the average subthreshold slope. An optimum ratio for the tunneling to auxiliary gate length that maximizes the device performance, is also extracted from simulations. We have demonstrated that the device performance of DMG-DGTFETs with scaling does not degrade. A comparison between the Dual-Material Gate (DMG) and Single-Material Gate (SMG) TFETs shows that even for scaled devices, the DMG technique continues to give better performance (higher ION/IOFF ratio and lower subthreshold slope) than the SMG technique. A 2D analytical model for the surface potential of DMGTFETs is also presented here. It incorporates the effects of drain and gate voltages, gate metal work function, insulator thickness, silicon film thickness, and source and drain depletion. The band-to-band generation rate is integrated to compute the tunneling current, considering the band-to-band tunneling to take place both at the source as well as the drain depletion regions. The model accounts for variable drain doping through a fitting function, which is based on the concept of generation current, and the results have been found to predict the correct ambipolar behavior of TFETs. The results of our model both for the surface potential and the tunneling current match very well with those obtained through TCAD simulations.

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Title	:	*Development of a new Analytical Model for the Drain Current of Double-Gate Tunnel FETs (DGTFETs)*
Author(s)	:	*Pal Arnab*
Roll No	:	*13104020*
Supervisor(s)	:	*Dutta Aloke*

Abstract:

In this work, we have developed an analytical model for the drain current of a Double-Gate Tunnel Field-Effect Transistor (DGTFET), which is derived by using the pseudo-2D Poisson's equation in order to get the surface potential in both the channel and the source regions. We have presented a new model for the surface potential, which is valid for the channel region being both under depletion and accumulation, along with an analytical model of the phenomenon of source depletion. We have also proposed a modification in the existing model for the band-to-band tunneling current by taking into account the change in the carrier momentum vector during its transit from the source valence band to the channel conduction band. Another important contribution of this work is the prediction of zero drain current at zero drain bias, which existing models failed to emulate, and is physically modeled for the first time here. The negative conductance region shown by the transfer characteristics at low gate bias is also modeled for the first time by using an empirical formulation, employing a solitary fitting function. Extensive TCAD simulations were performed in order to prove the veracity of our model with respect to drain bias, gate bias, substrate doping, and metal electrode, and the match was found to be excellent.

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Title	***:***	***Small-Signal Modeling of Laterally Asymmetric MOSFETs including Non-Quasi-Static Effects***
Author(s)	***:***	***Patel Naresh***
Roll No	***:***	***10327435***
Supervisor(s)	***:***	***Chauhan Yogesh Singh&Dutta Aloke***

Abstract:

The interest in accurate modeling of high voltage transistors like LDMOS and VDMOS has increased in recent years due to the compatibility of these devices with standard CMOS technology. However, the development of models for these high voltage devices depends on an accurate modeling of the LAMOS, which is the building block of these devices. Since due to the lateral non-uniform doping in the channel region, the Ward-Dutton charge partitioning scheme is not applicable for LAMOS, hence, the admittance parameters of the LAMOS are determined by solving for the small-signal real and imaginary components of current under the quasi-static assumption, i.e., restricting the magnitude of the frequency. In this work, we develop the admittance parameters without putting any restriction on the magnitude of the operating frequency of the small-signal voltages. This thesis rst explores the small-signal modeling of conventional MOS transis- tors under steady-state, quasi-static, and non-quasi-static situations. The connec- tion between these three situations is well elaborated, and it is illustrated that the model under the non-quasi-static situation reverts back to the quasi-static model when the operating frequency is low, and that in turn approaches the steady-state model, when the operating frequency becomes very small or zero. Second, it covers the DC modeling of the LAMOS, based on which, under the general non-quasi-static situation, the model for the small-signal admittance parameters is developed. It is shown that at low frequencies, these parameters show unusual capacitance charac- teristic exhibited by LAMOS. It is also shown that when the doping gradient tends to zero, in the limit, the proposed model reverts back to the conventional MOS transistor model. The results of our model for the y-parameters match very well with TCAD simulations up to a frequency of 20 GHz

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Title	:	*Design and simulation of the thin film solar cell Copper Indium Gallium Selenide (CIGS) and Copper Zinc Tin Sulfide (CZTS) using ATLAS , SILVACO*
Author(s)	:	*Choudhary Nisha*
Roll No	:	*10327453*
Supervisor(s)	:	*Iyer S Sundar Kumar*

Abstract:

The characteristics of copper chalcopyrite (CuInGaS_2 and Cu_2 ZnSnS_4) based thin film solar-cells have been studied using ATLAS a device simulation framework from SILVACO. In this study the simulated solar-cell characteristics obtained by varying the parameters like thickness of absorber and window layers, doping, band gap, and grain-boundaries have been correlated with the corresponding effects these parameters have on the photo-generation and transport of electrons and holes across the device. The simulation results have also been compared with the corresponding results available in the literature.

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Title	:	*Electrothermal Numerical Modeling of heterogeneous binary transition metal oxide based RRAM*
Author(s)	:	*Asapu Shiva*
Roll No	:	*10327152*
Supervisor(s)	:	*Chauhan Yogesh Singh*

Abstract:

Resistive-switching random access memory (RRAM) has received a lot of attention for the application as next generation non-volatile memory. Among the various materials investigated over the years, transition-metal oxides have shown great promises due to their fast switching, compatibility with the CMOS process and easy scalability. The fundamental challenge is the lack of a proper theory that accurately describes the resistive switching phenomenon. However, a conceivable theory has been developed over the years with the help of which modeling was made possible. Modeling a single layer resistive switching cell has been done in the literature. Heterogeneous bi-layers have been proposed recently in order to have a substantial control over the RESET current in resistive switching devices. In this thesis, we model a heterogeneous bi-layered stack of WOx/TaOx resistive-RAM (RRAM) or resistive switching (RS) cell. We use finite element method (FEM) to solve a set of 3 self-consistent partial differential equations (PDEs) using a numerical solver, COMSOL multiphysics. With two entirely different oxides forming a stack, one of them (WOx) would act as the reservoir of defects due to oxygen vacancies (Vo) and the other layer (TaOx) is the active layer wherein a conduction path (conduction filament) would be established

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Title	***:***	***Modelling and Simulation of Laterally Asymmetric Channel MOSFETS***
Author(s)	***:***	***Randhi Sai Kishore***
Roll No	***:***	***13104116***
Supervisor(s)	***:***	***Yogesh Singh Chauhan***

Abstract:

In this era of automation, requirement of High-voltage MOSFETs has increased manifold. The integration of High-Voltage devices and advanced Low-Voltage CMOS devices is becoming an increasing requirement for input/output interface of various System-On-Chip applications, such as Sensors, Power Management, Flat panel Displays and RF Power amplifiers. In the first part of the work done in this thesis, an Extended drain MOSFET (EDMOS) device is generated and simulated by using Sentaurus Technology Computer Aided Design (TCAD) and the device characteristics are observed. In addition we consider Dual Work Function Gate concept and Super Junction concept to improve the device characteristics. In the second part of the work done in this thesis, the spatial composition grading of a binary metal alloy is considered as gate material for EDMOS transistor. Titanium with work function of 4.4 eV and Platinum (Pt) with work function of 5.3 eV are considered elements for this binary metal alloy. The variation of the surface potential for different channel lengths is calculated, and then is used to calculate the threshold voltage for these devices. The threshold voltage obtained is then used in the threshold voltage based compact model to get the I □V characteristics of the given devices. The results obtained for these devices are compared with the data obtained from TCAD simulations for different lengths of the channel. The fitting results of the model with the TCAD simulations show quite good fitting.

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Title	***:***	***Investigation of Band to Band Tunnelling in Quantum-Well MOSFETs***
Author(s)	***:***	***Kumar Rohit***
Roll No	***:***	***10327610***
Supervisor(s)	***:***	***Iyer S Sundar Kumar***

Abstract:

This thesis attempts to understand and calibrate the Band to Band Tunneling (BTBT) in Quantum Well (QW) III-V Metal Oxide Semiconductor Field Effect Transistor (MOSFET). This is crucial for proper prediction of the lowest OFF current (IOFF) achievable in the low mass (hence attractive), but concomitantly low band gap (concern with BTBT) materials. Here In0.7Ga0.3As MOSFET of different channel and gate length will be investigated. We will focus on experimentally varied device design parameters like drain –gate overlap, oxide thickness, drain voltage, channel and gate length and temperature. The primary phenomenon that will be studied due to the BTBT is the so-called Gate Induced Drain Leakage (GIDL). The main focus of this thesis is to analyse the BTBT pattern in different device configurations, and to calibrate the model parameters to match the experimental data. Proposals to reduce the BTBT leakage will be proposed. In this thesis, simulation has been started with basic device structure and finally experimental structure has been simulated.

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Title	:	*Dual and Triple Band Bandpass Filter realization Using Split Ring and Spiral Resonator for Significant Size Reduction*
Author(s)	:	*Kaur Priyajeet*
Roll No	:	*13104106*
Supervisor(s)	:	*Biswas Animesh*

Abstract:

In the era of wireless communication, various research fields are emerging. Microwaves are providing excellent source to operate various communication devices. Researchers in the field of Microwaves and RF are facing challenges at different levels of application developments. Filters are fulfilling the requirements to segregate the required frequency bands, It covers an important circuit in RF Transceiver. There has been an extensive research on this topic, Still new methods are being designed so as to make designs as robust and efficient as possible. Planar filters have an extra advantage of being extremely space efficient and thus can be accommodated on chip along with other front end elements. The thesis presents design of Dual and Triple band Bandpass filter using two different unit resonator cell. Split Ring and Spiral resonator properties are utilized to design dual and triple band respectively. Various methods are utilized to enhance the response of filter in Dual band filter design. Coupling properties are studied. Coupling matrix approach is utilized to design Triple band filter design. Simulations are done using HFSS and ADS Momentum. The Designed structures are fabricated in PCB Lab. Measurements are done using Vector Network analyzer for the fabricated Designs. Results are analyzed and explained.

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Title	***:***	***Studies on Multilayer Substrate Integrated Waveguide Slot Coupler and its Application to Microwave Circuits***
Author(s)	***:***	***Biswas Animesh***
Roll No	***:***	***13104119***
Supervisor(s)	***:***	***Biswas Animesh***

Abstract:

A resonating slot possesses the property to radiate as well as can be used to couple power from one waveguide to another waveguide. In this thesis, Characterization of slot coupler has been taken as the basic building block for designing of 1 to 2n way power divider. This thesis also investigates substrate integrated waveguide (SIW) technique based slot couplers and its application as antenna array feeding structure. Substrate Integrated Waveguide (SIW) is a technique to design planer waveguide in which metallic via places in such a way so that it can propagate power with minimum power leakage from the walls. SIWs exhibits compact size, low cost and highly immune to the electromagnetic interferences in microwave and millimeter wave technology. Behavior of coupling slots for a range of tilt angle, frequencies and resonant length are presented. The proposed design principle has been described on the characterization results of the double layered cross coupled SIW slot coupler. An application of the proposed SIW coupler as 1 to 2 power divider is also presented. The multilayer behavior and SIW technique make the structure compact which occupies less space as compared to traditional power dividers. The proposed design works for 474 MHz (4.65% for -15 dB) of the bandwidth and can be used as a feeding network for the SIW based waveguide slot array antenna.

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Title : ***Studies on internal and external cloaks for improved cloaking performance using realizable material parameters***

Author(s) : ***Vura Pravallika***

Roll No : ***13104104***

Supervisor(s) : ***Srivastava Kumar Vaibhav***

Abstract:

Research on metamaterials has been growing ever since the first experimental realization of a double negative medium. Metamaterials give enormous choice of material parameters for electromagnetic applications. The theory of transformation optics(TO) provides a great tool to exploit the vast possibilities of the constitutive parameters of metamaterials. The main tool associated with TO is that of coordinate transformations, in which isotropic space is conceptually warped or otherwise distorted as a means of guiding the trajectories of waves. A lot of fascinating optical devices that uses transformation optics have been identifi ed, especially invisibility cloaks. The aim of this thesis is to adopt the techniques of transformation optics in order to design novel invisible cloaking devices that contributes to improvement in cloaking performance and better realizability of material parameters. Firstly, a parabolic transformation function instead of linear transformation function has been utilized in internal cloaking for smaller dynamic range of material parameters with lower scattering. Two kinds of simplifi ed material properties namely, reduced parameters and modifi ed reduced parameters are obtained by using the proposed parabolic transformation function. An extra degree of freedom with parameter `p' is present in designed cloaks whose value is governed by monotonicity condition. This parameter provides flexibility between impedance matching and dynamic range of material properties. Both simplifi ed cloak designs have finite material property at the inner boundary. In the case of modi fied reduced parameters, the cloak is having perfect impedance match at the outer boundary of the cloak for any thickness of the cloak whereas impedance matching in the case of reduced parameters is dependent on `p'. The scattering characteristics of the proposed quadratic cloak is compared with the linear cloak, signifi cant improvement in invisibility performance is noticed for the proposed one with respect to the earlier reported linear cloak. When a thin cloak shell is desired, the proposed cloak with modifi ed reduced parameters (that are realizable) is much more superior than the linear cloak, as the cloaks outer surface is impedance-matched to free space for any thickness of the cloak. Secondly, two composite shaped external cloaks are proposed based on the concept of linear transformation method and complementary media. Each composite shaped cloak is sub-divided into regions of rectangular and triangular shapes. The advantage of the proposed cloak designs is that the material properties are finite, homogeneous and nonsingular within all sub-regions of the cloaks which is good for practical realization. The cloak size of each of the proposed designs is smaller compared to the conventional external cloaks. Moreover the cloaking area of proposed cloaks can be increased in the vertical direction without any change in material parameters of core and complementary regions which is an additional bene fit for hiding long objects. Full-wave simulation results demonstrate that the proposed complementary invisibility cloaks has a good performance for cloaking multiple target objects Finally, to increase the cloaked area in the above design, we can interchange the core & cloaked regions of above cloak design and introduce an identical structure symmetrical to it which gives hexagonal shaped reciprocal cloak which possess all the advantages of the above design along with an additional advantage of increased cloaking area. By utilizing the concept of transformation optics and complementary media, a hexagonal shaped reciprocal external cloak is proposed. The hexagonal shape has been sub-divided into regions of rectangular and triangular shapes. The rectangular sub-regions have diagonally anisotropic material properties whereas the triangular sub-regions have complete anisotropic tensor properties. The advantage of proposed cloak is that the material properties are homogeneous within all sub-regions. The other advantage is that its cloaked area can be increased in X-direction without any change in material parameters. Fullwave simulations reveal that the proposed cloak has good performance even for hiding multiple objects.

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Title	***:***	***Design of X-Band Power Amplifier based on GaAs-pHEMT Technology***
Author(s)	***:***	***Makwana Milan Kiritbhai***
Roll No	***:***	***13104073***
Supervisor(s)	***:***	***Biswas Animesh***

Abstract:

The field of communication has seen significant and unprecedented progress in the past decade. Power amplifiers are one of indispensable components in radar, modern communication systems, and local multipoint distribution system (LMDS). The need for higher data rates, reduced cost, and submicron size device technology makes MMIC power amplifier technologies at X-band very attractive. As during transmission of signals through medium there are several losses occurs so, it is required to amplify the signal with large power. This thesis presents a design of an X-band power amplifier based on GaAs pHEMT technology. The design accuracy depends upon the device model. It is imperative to have a meticulous device model for the broad frequency range to use in simulation tools. For this measurement based millimeter wave bias dependent model based on S-parameters for the 0.1 µm gate length GaAs pHEMT having gate peripheries of 2x25 µm (number of gate finger x unit gate width) is fabricated on the 2mil (50.8 µm) GaAs/AlGaAs/InGaAs substrate using PP10-10 process from WIN foundry. Measurement includes pulsed I-V and on wafer scattering parameters for the frequency range of 45 MHz to 110 GHz for this device. In this work, a two stage power amplifier design across 9-11 GHz, X-band using circuit simulation in Advanced Design System (ADS) is designed. The device technology used for this design is PP10-10 process from WIN foundry. The resultant circuit typically provides saturated output power of 23.5 dBm, a gain of 29 dB, input and output return loss greater than 13 dB and 8 dB respectively. The power added efficiency (PAE) for the present design is 22%.

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Title	:	*Design of X-Band low phase-noise oscillator and comparative analysis of the two topologies*
Author(s)	:	*Shrivastva Vivek*
Roll No	:	*13104160*
Supervisor(s)	:	*Biswas Animesh*

Abstract:

The need of higher bandwidth, higher performance, functionality, size, power consumption requirements with advances in technology has always been a topic of interest. In Present medical facilities like remote surgery, high precision detection devices like X-rays, MRI require an e cient source. In addition to this, Navigation systems like GPS, GLONASS and IRNSS etc., modern digital systems, communication systems and various RADAR technologies cannot be imagined without an oscillator. In all, oscillators are the key components for almost every system in present world and a small amount of unpredictable performance in an oscillator used in these systems leads to the failure of a good and e cient system. The main aim of this thesis is to develop a comparison in the two widely used microwave oscillator design approaches viz. feedback approach and negative resistance approach. First, a novel high selectivity band-pass microstrip lter has been designed. This lter has been used to provide su cient Quality factor to the oscillator circuits according to Leeson's model for phase noise. The major portion of the thesis covers the design methodology to design a microwave oscillator using above mentioned two approaches. The operational band for the design in this thesis is X-band. As a concluding remark, the last chapter highlights comparison between X-band negative resistance oscillator and X-band feedback oscillator.

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Title	:	*Design of power amplifier*
Author(s)	:	*Sharma Sonu*
Roll No	:	*13104145*
Supervisor(s)	:	*Biswas Animesh*

Abstract:

Power amplifier is an important key member in communication. Power amplifier as high output power amplifier or high efficiency power amplifier is used at the transmitter side and low noise amplifier is used at receiver side. The GaAs pHEMT is very good device to use as power amplifier. This work is divided in two part, in the first part device is modelled so as to get same response after the fabrication. Generally design tool gives the device which is almost different from fabricated device because after the fabrication process it has many non-ideal components which does not give the similar response to the simulated design. Thus the modelling has been done for different bias points. In the other part I have designed the class A power Amplifier which gives 13.250 dBm output power and its power gain is 8.917 dB at 15 GHz operating frequency. The device is used for the design of power amplifier is GaAs pHEMT, whose gate width is 25 µm and length is 0.1 µm. In the end I have shown some trade-offs in the design of the power amplifier which are between efficiency and linearity, between power gain and efficiency and between power gain and output power. Power added efficiency of the power amplifier is 36.722%. Ideally efficiency of class A power amplifier should not be more than 50%.

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Title	:	*Design of Broad Band Bias-T on Alumina Substrate*
Author(s)	:	*Kumar Sonu*
Roll No	:	*13104144*
Supervisor(s)	:	*Das Utpal*

Abstract:

Abstract:

In this work, microstrip line based Bias-Ts have been designed using HFSS software to work in the frequency band 4.8-100GHz on alumina substrate. In this design a taper has been introduced in the high frequency (HF) line to improve the isolation of the DC line from the signal HF. A novel MIM capacitor has been introduced in the HF line to obtain DC from one of the HF ports, which did not impede HF transmission. Two alumina substrate thicknesses, namely 0.65mm and 0.1mm, have been used for the design. For the 0.65mm substrate, an HF transmission of ~ -4dB from 4.8-50GHz has been obtained with a minimum isolation to the DC port of ~ -25dB or better from 4.8-50GHz. The corresponding VSWR is 1.02-3.50 in the same HF range. The masks for the fabrication have also been prepared and initial process steps performed. The 0.65mm alumina substrate device showed limitations at > 30GHz while Bias-T design on the 0.1mm substrate shows an HF transmission > -3dB for 7.5-100GHz band except for 17.3 and 85.4GHz (-3.96dB and -3.28dB). Isolation from DC port is < -20dB and the corresponding reflection is below -8dB in the 7.5-100GHz band. The VSWR being 1.04-2.40 puts this device performance at par with the industry standards. The first design can easily be implemented for Bias-T for 40Gbps photodiodes, using V-connectors, which were purchased and the package designed, but could not be completed. On the other hand, the second design, although similarly implementable, needs the more expensive and more difficult to handle, W-connectors. Measurements facilities are also not easily available in this frequency range of ~ 100GHz. However, it is left to a further researcher to implement it which would find useful applications in the W-band (75-100GHz).

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Title : ***Design of broadband Bias-T on GaAs substrate***

Author(s) : ***Shah Mithil***

Roll No : ***13104136***

Supervisor(s) : ***DasUtpal***

Abstract:

Large bandwidth operation up to 50 and 100GHz Bias-Ts have been designed on GaAs substrates of thicknesses 450um and 200um, respectively. The dimensions for the 100GHz Bias-T is 9.52mmX10.42mmX0.2032mm. 350nm Au conductors is used for microstrip conductor and ground plane design. For adhesion of Au on GaAs, a 50nm Ti layer is designed to be coated on GaAs before Au coating. Both HFSS and ADS software has been utilized for the design. The design uses three butterfly stubs for HF isolation to the dc bias path. The butterfly stubs are centred at 3.75, 12.58, and 19.58GHz of angles 15°, 60°, and 45°, respectively. The stubs were placed at approximately λg/4, λg/4, and 5λg/4 from the T-junction, respectively. The minimum HF isolation to the dc path achieved is 20dB from 4.5-100GHz. To eliminate the detrimental notches in S21 at frequencies between 10-20GHz and 30-40GHz, a 10-42Ω microstrip taper is used in the design. The length of taper on either side of the T-junction is λg/4 at ~5.5GHz. A novel inline capacitor comprising of two conductor separated by ZrO2 insulator has been added on the taper at the high-frequency port side for dc blocking. This can be easily achieved on GaAs using standard photolithography and lift-off technique. A flat transmission response (S21) is obtained with a maximum of ~2.9 dB insertion loss at ~38 GHz. Isolation of >25dB is obtained on the entire band of 4.9-100GHz except 16dB in a narrow band around 38 GHz. A return loss of 7dB is obtained upto 6GHz and >10dB is obtained upto 100GHz. An advantage of this design is that using V-connectors and without the m thick GaAs substrate one can operate the device toμneed to use a 200 50GHz. For 100GHz operation lapping of a standard 450um thick GaAs would be necessary.

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Title	***:***	***Design of Planar Resonator Sensor for RF Testing of Liquids***
Author(s)	***:***	***Samant Himanshu***
Roll No	***:***	***13104053***
Supervisor(s)	***:***	***Akhtar M Jaleel***

Abstract:

Measurement of dielectric properties of liquids in the RF and Microwave frequency range has got various applications such as contamination detection in agricultural and food products, testing of blood samples for biomedical applications, microwave heating in polymer and composite industry, etc. The contamination in various food products can be detected by observing the changes in the dielectric properties of the food sample as comparing to that of the reference sample. Similarly the change in dielectric properties of infected blood samples with respect to these properties of the blood samples of a healthy person can be monitored for some biomedical applications. In this work, a non invasive planar resonator sensor is developed for determination of dielectric properties of liquid samples, which has then been tested for detection of contamination in various reference samples. The designed sensor is made non-contacting by covering the resonator area with a thin polypropylene sheet. The proposed resonator sensor is first realised on the central metallic strip of a coplanar waveguide, whose characteristic is similar to that of a band stop filter. The proposed resonator is compared with the interdigital capacitor (IDC) resonator, which is also realised on a coplanar waveguide. The proposed resonator sensor is found to have better sensitivity than the IDC resonator sensor and hence appears to be more appropriate choice for RF testing of liquid samples. A numerical model of the proposed resonator sensor is developed using the electromagnetic simulator, the CST studio, for determination of the complex permittivity in terms of the resonant frequency and quality factor. Effect of the polypropylene sheet on the sensitivity of the sensor has been analyzed. The designed coplanar resonator sensor is fabricated on a FR4 substrate, and a hollow cylindrical container is placed around the resonator area to contain the liquid samples by taking its effect into account. The loading of sensor with the dielectric test specimen changes the capacitance of the proposed resonator which causes a shift in the resonant frequency. The perturbed frequency is used for the measurement of the dielectric properties of liquid samples. The numerically established relations are experimentally verified for various liquid samples like Benzene, Ethyl Acetate, Pentane, Ethanol, water etc. It has been observed that the proposed coplanar resonator sensor can accurately characterize various chemical solvents with a maximum error of 4 %. The proposed technique is then extended to design a dual band coplanar resonator sensor which may be advantageous for the characterization of dispersive liquids. The proposed dual band sensor is designed to operate at the two ISM (Industrial Scientific and Medical) bands. The permittivity values of different liquids calculated using the proposed sensor are compared with the data available in literature.At last, the proposed resonator is realised on a microstrip line in order to compare its performance as compared to the CPW based sensors. An experimental modelling is proposed using this resonator sensor to determine the molarity of acetic acid solution in terms of fractional change in the resonant frequency of the resonator. The proposed microwave method to determine the molarity of liquids can be advantageous under certain situations as compared to that of the conventional titration method which is actually time consuming for some cases due to the involved chemical reaction, and where the sample under test cannot be recycled.

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Title	:	*Design of Multi Slot Vivaldi Antenna with Improved Directivity for Microwave Testing Applications*
Author(s)	:	*Kumar Pankaj*
Roll No	:	*13104098*
Supervisor(s)	:	*Akhtar M Jaleel*

Abstract:

In this thesis, the multi slot Vivaldi antennas are designed, fabricated and tested. The Vivaldi antenna is basically a travelling wave end fire antenna, which is well-known for ultra-wide band (UWB) characteristics. These types of antennas are being used to for various applications such as the pulse radar, remote sensing, military mobile wireless systems, microwave imaging etc. The microwave imaging technique is presently being explored to be used in airport security, aerial surveillance, through wall imaging etc. Currently, to achieve good spatial resolution and penetration of EM-wave through the object under test, there is a huge interest to develop UWB antennas with high gain and narrow 3dB beamwidth. The Vivaldi antenna having good directivity and UWB characteristics appears to be a viable candidate for the microwave imaging applications. However, the conventional Vivaldi antennas exhibit somewhat low directivity and high 3dB beamwidth than the desired value although they possess quite good UWB characteristics. It is mainly due to this reason that in this work, the modified Vivaldi antenna having multi slots has been proposed to achieve higher directivity and narrower 3dB beamwidth without compromising its UWB characteristics. In this framework, first a compact double slot Vivaldi antenna (DSVA) for 2-10GHz frequency band with improved directivity ranging from 3.5-10.0 dBi is designed, fabricated and tested. Afterwards, an anisotropic zero index metamaterial (AZIM) cell was loaded into the E-plane of the designed DSVA to improve its directivity. The measured results of AZIM loaded DSVA are found to be in good agreement with the simulated results. In the next step, the four slot Vivaldi antenna (FSVA) is proposed in order to further improve the directivity and to reduce the 3dB beamwidth as compared to the DSVA. In order to feed the four slot Vivaldi antenna, the Wilkinson power divider and the T-junction power divider are proposed and compared on the basis of their performance in the operating frequency band. It was found that the T-junction power divider using binomial transformer had wider bandwidth. Also, unlike the Wilkinson power divider, the T-junction power divider usually does not require any lumped element. Hence, the proposed T-junction power divider is subsequently used to feed the newly proposed FSVA. The directivity of the designed FSVA is found to improve typically by 4 dBi, while the 3dB beam width is typically reduced by 30° in the operating frequency band as compared to that of the DSVA. The fabricated FSVA has been tested for the microwave imaging and testing to reconstruct the image of one and two objects hidden inside the test media.

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Title	***:***	***Continuously Tunable Multi-wavelength Ultra-Fast Fiber Ring Laser***
Author(s)	***:***	***Chandra Nishanth***
Roll No	***:***	***13104094***
Supervisor(s)	***:***	***Kumar Pradeep***

Abstract:

Ultra-short pulses in mode-locked lasers are a topic of extensive research due to their wide range of applications from optical clock technology to measurements of fundamental constants of nature and ultra-high speed optical communications. Ultra-short pulses are especially important for the next generation of ultra-high speed optical systems and networks operating at 100Gbps. Pulse sequences with pulse-width on the order of few picoseconds are best probable choice for the generation of multi-Gbps optical carrier data. In this thesis, a continuously tunable multi-wavelength ultra-fast fiber ring laser at 10 GHz repetition rate is studied experimentally. A novel way to induce polarization and wavelength dependent loss in the laser cavity is proposed. This makes the mode-locked laser tunable over a wide range of C band and also makes multi-wavelength operation possible. The stability of the laser is measured and a software based feedback loop is developed to improve the laser's long term stability. Finally, a method is proposed to generate other useful pulse shapes like rectangular waveforms from the ultra-short pulses obtained.

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Title	***:***	***An Inverse Scattering Approach To Design Small Size Microstrip Filters Using Defected Ground Structures***
Author(s)	***:***	***Sannake Rohit***
Roll No	***:***	***13104124***
Supervisor(s)	***:***	***Akhtar M Jaleel***

Abstract:

Planar microwave filters have gained much popularity in RF applications due to their light weight, low cost, and easy integration to active devices. Conventionally many analytical and numerical methods exist for microwave filter design. In recent years, the inverse scattering approach has been explored to design RF and microwave filters. One of the advantages of the filter design using the inverse scattering approach is that the structure geometry can directly be obtained in terms of the reflection coefficients, and even continuously varying transmission lines can be realized. The Riccati differential equation approach is one of the inverse scattering methods, which provides a stable solution for filter design as compared to other inverse scattering approaches. However, one of the bottlenecks in the design of RF filters using the inverse scattering approach has been the large size of the filter in order to realize the specified response. In this thesis, a new method is proposed for length minimization of the filter which is designed using the inverse scattering approach. In this technique, the effective length of the designed microstrip filter is increased using the Defected Ground Structures (DGS). This basically means that the characteristics of the filter remain almost unchanged even after reducing the actual physical length of the designed structure. The periodic DGS increases the effective inductance and capacitance of the microstrip line, which causes slow wave effect in the device. Hence, the actual effective length of the filter increases through this DGS for the same physical length. Different types of DGS are employed here to reduce the overall size as well as to improve the performance of the filter. Based on the proposed approach, low pass and band stop microstrip filters are designed, and their performance is first verified using independent simulation tools. After validating the design, these filters are fabricated on FR4 substrate, and their characteristics are measured using the network analyzer in the designated frequency bands. The proposed method provides an overall reduction of the length of low pass and band stop filters by almost 60% and 30 % of their original lengths, respectively.

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Title	***:***	***Fractal Geometry Inspired Polarization Insensitive Microwave Absorbers for Multiband and Broadband Applications***
Author(s)	***:***	***Praneeth Munaga***
Roll No	***:***	***13104084***
Supervisor(s)	***:***	***Srivastava Kumar Vaibhav***

Abstract:

With the advent of radar, the necessity of passive devices that are capable of absorbing these radio waves has also emerged resulting in various designs of microwave absorbers. These microwave absorbers are designed in a number of frequency domains ranging from microwave to infra red regime. Some of the important applications of the absorbers are solar cell, bolometer, anechoic chambers, stealth technology, reduction of radar cross section etc. Because of massive and bulky nature of the conventional microwave absorbers they require large area for installations and cannot be used in practical applications. The solution of achieving near unity absorption with light weight and very thin structures can be facilitated by making use of unusual electromagnetic properties of metamaterials. However the absorption of these metamaterial absorbers is limited to a narrow band of frequencies thereby making them not suitable for wideband and multi-band applications. Hence many design methodologies have been proposed for multi-band as well as broadband applications with significant increase in lattice dimension. This thesis focuses on miniaturizing metamaterial absorbers for multi-band and broadband applications. The compactness of the proposed metamaterial absorbers is retained by making use of the space filling characteristic of the fractal geometry. Firstly, a dual-band polarization-insensitive, wide angle metamaterial absorber has been designed comprising of tetra arrow cave shaped unit cells. The compactness of this absorber structure is compared with other reported structures. Secondly, a concentric Minkowski fractal loop based absorber structure has been proposed which is capable of absorbing six distinct frequencies. Then by tuning the geometric dimensions of this absorber structure, bandwidth enhancement at two different frequency bands (X-band and Ku-band) has been achieved. Finally, a broadband absorber based on mounting of lumped resistor method has been designed for C-band applications. The unit cell of this absorber structure comprises of inverted Minkowski fractal loop along with lumped resistors. The compactness of this structure is also compared with earlier reported structures.

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Title	:	*Analysis and Design of Ultra Wideband Wearable Antennas*
Author(s)	:	*Yadav Rajesh Anand*
Roll No	:	*13104114*
Supervisor(s)	:	*Harish A R*

Abstract:

Ultra Wide Band technology promises many innovative and commercially feasible applications. It is expected by many visionaries that these ultra wide band technology enabled Devices can be employed in body wearable and portable consumer products. Antenna for wearable and portable applications have to face severe size and volume constraints due to limited available size and mounting issues. Therefore antenna having compact size and small form factor are highly desirable for commercial applications. High data rate applications demands that the radiation pattern behaviour remains consistent across the bandwidth along with impedance performance. These difficulties and challenges faced by designer leads to differentiation of these UWB antenna designing from conventionally available antennas having narrowband characteristics. In this thesis work three low profile antennas are fabricated on two different substrates (leather and FR4).The measured results are compared with simulated results in terms of reflection coefficient and radiation patterns. For these antennas to work properly, the ground plane size is required to be electrically much larger so as to approximate an infinite ground plane and thus occupies a larger portion of the overall system. For designing a compact antenna ground plane size need to be minimized. Generally antenna structures are simulated in EM simulators without considering feeding cable so as to reduce computational burden on it. However, when final product is prototyped for measurements it has to be fed through feeding cable. Due to small physical size of antenna ground plane the currents flow back on outer surface of cable. The standing wave pattern is formed on the feeding cable and will result into radiation which disturbs original radiation pattern. In order to minimize the ground plane effects, L shaped slots are introduced in ground plane. Thus the current distribution in ground plane can be altered to reduce effects of small ground plane size. When slot is not introduced in ground plane current distribution is a function of frequency. With introduction of slot on the ground current distribution is confined by the slots. Even at higher frequencies current distribution is slightly disturbed still it is confined by the slots. This leads to less dependency of antenna performance in terms of ground plane size. In order to understand the working of antenna or predicting its behaviour when integrated with system and used in communication system equivalent circuit model was derived for a better understanding of antenna working principle. The Vector fitting algorithm was used to derive equivalent model for antenna structure. Measurement of electrical parameters of any material helps in modelling that material in simulation environment which leads to minimum difference between simulated results and measured results. Characterising materials before using them in antenna design is the first step in antenna design workflow. The leather is characterised in this thesis with sole purpose of integrating antenna in body worn applications. To study the effect of human body on the performance of antenna, it is placed on three layered human model.

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Title	:	*Compact And Enhanced Bandwidth Polarization Reconfigurable E-Shaped Patch Antenna*
Author(s)	:	*Velma Reddy Chandrashekar Reddy*
Roll No	:	*13104154*
Supervisor(s)	:	*Harish A R*

Abstract:

In modern communication systems, the antenna which can perform different tasks depending up on the environment is more desirable. Generally a reconfigurable antenna refers to that antenna which has the capability of changing polarization, radiation pattern or frequency of operation. Their diversity and agile nature created a new dimension of applications in Multiple Input Multiple Output systems, Cognitive radio, satellite and many other systems where communication is involved. Reconfigurable antennas have increased functionality such as producing different polarizations, beam steering etc., in the confined volume. The aim of this thesis is to design a compact and enhanced bandwidth polarization reconfigurable E- shaped patch antenna. The compactness in the antenna can be obtained by removing the λ/4 DC bias stub which occupies 20% of length and by introducing a C-slot inside the outer patch of the E-shaped patch antenna reduces the size of the antenna. Introducing shorting pin at the appropriate positions in the antenna between the upper patch and the ground provides DC return path. By changing the feeding technique, not only the individual bandwidths of axial ratio (25%) and input reflection coefficient (19.23%) are improved but also the overlap of frequency bands of S11 (< -10 dB) and axial ratio (< 3 dB) has improved well from 7% to 19.23% with a 5.5 dBic maximum realized gain. Practical issues like availability of pin diodes and implementation of shorting pins are considered and the shown results are discussed to validate the new changes incorporated in it.

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Title	***:***	***Design, Fabrication and Characterization of a Vacuum Gated Diode***
Author(s)	***:***	***Vashistha Sachin***
Roll No	***:***	***13104128***
Supervisor(s)	***:***	***Das Utpal***

Abstract:

High - speed electronic devices rely on short carrier transport times, which are usually achieved by decreasing the channel length and/or increasing the carrier velocity. Scaling down of the semiconductor transistor has reached its physical limit and also their speed of operation. Vacuum is the superior carrier conveying medium than any other solid materials, because electrons do not suffer from scattering with the atoms as in semiconductors. Thus limiting speed of operation of the device is determined by RC time constant only. This type of vacuum channel transistor is also useful in display devices mostly made on glass or a dielectric sheet. A detailed study of a vacuum microelectronic devices is presented here. Two types of vacuum gated diode have been analyzed, namely (a) metal electrodes and (b) InGaAs electrodes. Channel lengths considered is 20nm. A simulated operational voltage of 10 – 35V shows current flows were obtained in the range of 50 - 1000μA. A current variation of 50 - 500μA was obtained for a gate voltage variations of 10 – 35V for a fixed anode – cathode bias of 10V. For the highest currents a maximum power dissipation for the device is found to be of ~1nW. Fabrication steps for the diode and triode devices using photolithography and FIB is also presented here. Result of a fabricated Al-emitter diode shows that the anode-cathode current measured is almost one third of the simulated value. This discrepancy is attributed to non-uniform anode as well as anode edges arising from uncontrolled fluctuations in the focused ion beam used for milling the nano-scale structures. At 35V the device burnt at a current of ≤500μA due to local heating at the imperfect edges. Hence the triode fabrication could not be implemented.

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Title	***:***	***Design implementation and control of low voltage DC microgrid***
Author(s)	***:***	***Munagala Chaitanya Sai***
Roll No	***:***	***12104043***
Supervisor(s)	***:***	***Das Shyama Prasad***

Abstract:

In the present work, a basic DC microgrid comprising of utility grid connecting unit, PV generation unit and battery storage unit, is designed, implemented and controlled. A voltage source inverter for grid connection, a bidirectional converter for battery interface and a simple boost converter for PV interface have been used. These three units are implemented and controlled independently. The Utility Interface Converter (UIC) is modelled in synchronous dq reference frame under both balanced and unbalanced utility grid conditions. Voltage oriented control scheme in dq reference frame is used for rectifier current control. In general, microgrids are connected to utility at distribution level, which is prone to get unbalanced due to single phase loads. When the rectifier is connected to an unbalanced utility, second harmonic oscillations are generated in injected power, due to interaction between opposite sequence voltages and currents. An improved control strategy is proposed to attenuate these oscillations, while interfacing microgrid to unbalanced utility grid. The PV Interface Converter (PVIC) and Battery Interface Converter (BIC) are modelled in state space averaging approach. To emulate the behaviour of renewable source, PV generation unit is operated in constant power mode. The BIC charges the battery in buck mode and operates in boost mode while discharging. For both charging and discharging regimes, control strategies are designed and implemented. A distributed control strategy based on terminal parameters of the units is proposed to control the DC microgrid. To suppress the circulating currents between units when connected in parallel, droop method is used. Simulation analysis is carried out in MATLAB SIMULINK to evaluate the performance of proposed control schemes. A Lab prototype type has been developed for experimental analysis. Controllers are implemented in TMS320F28335 DSP experimental kit. Hardware results show good correlation with theoretical and simulation analysis.

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Title	***:***	***Hall Effect Current Sensor using Transconductance Amplifier***
Author(s)	***:***	***Sudheer Jillelamoodi***
Roll No	***:***	***12104027***
Supervisor(s)	***:***	***Sensarma Partha Sarathi***

Abstract:

All the modern conveniences today rely heavily on the current sensors. Rail current is a very important to be measured in traction environment, the need arose for a reliable, large bandwidth and dynamic range rail current sensor. A current sensor with high bandwidth and good dynamic response is desired in these applications. For that application, 1A accuracy for the DC component measurement is sufficient and is performed by a Closed loop Hall effect transducer. Closed loop Hall effect based transducer also have fast response time, support high frequency signals of the current from the high switching frequency of the inverter, and to achieve accurate control of the speed. In the present work a closed loop Hall effect current sensor is designed and implemented. Initially a closed loop Hall effect current sensor is modeled and the model is used in designing the compensator. The transconductance amplifier is constructed using linear MOSFETs. All the issues in the design process and limitations are addressed. The experimental results of the transconductance amplifier as well as overall closed loop circuits are also discussed.

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Title	:	*Observability analysis and topology error processing of power systems in the presence of hybrid measurements*
Author(s)	:	*Sharma Neeraj Kumar*
Roll No	:	*13104088*
Supervisor(s)	:	*Chakrabarti Saikat*

Abstract:

Phasor measurement units (PMUs) are increasingly being used in modern power systems due to their high reporting rate and accuracy. The majority of the measurement devices in the existing power systems, however, are conventional asynchronous measurements. State-of-the-art state estimation algorithms are therefore required to include the hybrid set of measurements. Observability of the system with the given set of measurements is a pre-requisite of any state estimator. This thesis proposes a numerical algorithm for observability analysis of power systems having hybrid measurements. The proposed method is demonstrated with the help of a number of test systems. Topology processing is a vital function of a power system state estimator. Detection, identification, and processing of the topology error are pre-requisites for successful execution of the state estimator. This thesis proposes an optimization technique for topology error detection of power systems in presence of hybrid measurements. The proposed technique is tested on the number of test systems.

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Title	:	*Optimal demand response for PV-Integrated households*
Author(s)	:	*Naik Kishankumar M*
Roll No	:	*13104068*
Supervisor(s)	:	*Chakrabarti Saikat*

Abstract:

Electricity is the principle driving force of the modern world. The demand for electricity is higher than ever. The stress on the power system is increasing continuously, with increasing peak demand. The increase of conventional generation units such as power plants cannot keep up with the ever rising demand. There is need for better demand management, greater local generation, and uninterrupted power supply. Demand Response programs are the key drivers of demand side management. In this thesis, a demand response algorithm is proposed to optimally schedule the residential appliances, while incorporating generation from the photovoltaics (PV). An optimization problem is defined to minimize the cost incurred by the residential customer. Among the constraints, customer load preference, appliance ratings, and solar PV generation are considered. This optimization problem is then solved in MATLAB to obtain a scheduling vector for each controllable appliance. With the obtained optimal schedule, peak shaving/shifting is achieved and the customer is able to save significantly on the electricity bill. Rooftop solar PV produce clean energy locally and is a viable option for house- hold applications. With the use of battery, the issue of interruption in power supply is addressed. A grid connected solar PV system and a backup battery system, connected to a IEEE 13-node test feeder are simulated in Real Time Digital Simulator (RTDS). The e ectiveness of the proposed demand response scheme with local generation and uninterrupted supply is verified.

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Title	***:***	***Online Health Monitoring of Aluminium Electrolytic Capacitors For Single Phase Grid Connected PV System***
Author(s)	***:***	***Arya Abhinav***
Roll No	***:***	***13104003***
Supervisor(s)	***:***	***Anand Sandeep***

Abstract:

DC-link aluminum electrolytic capacitors (AECs) are used in single phase solar PV inverters to suppress second harmonic and switching voltage ripples. Electrolytic capacitors are less reliable than other components of PV system. Degradation of these capacitors affects the performance of the system. Reduction in capacitance and increase in equivalent series resistance (ESR) due to ageing increases ripples in dc voltage. DC-link voltage ripple causes oscillations in PV operating point thereby reducing PV power extraction efficiency. The worsen effect of growing dc-link voltage ripples is the breakdown of complete system. Two different techniques are proposed in this thesis for online health monitoring of AEC. First technique is based on the online monitoring of PV power extraction efficiency. Electrolytic capacitor is selected for power extraction efficiency greater than 99%. Replacement of capacitor is suggested based on deterioration in extraction efficiency. However, frequent replacement of capacitor increases cost of maintenance. Therefore, optimal value of extraction efficiency is determined in this paper, at which total payback period including maintenance cost is minimized. Second technique is based on the extraction of capacitor impedance at twice the grid frequency. The capacitor current is estimated from inductor current and the states of the switches. This eliminates the need of a large bandwidth current sensor for capacitor current. A narrow bandpass filter is used to extract the second harmonic component of voltage and current of capacitor. The ratio of the two gives the second harmonic impedance. Suitable limit on the impedance is defined, after which capacitor should be replaced. Detailed simulation studies are carried out using Simulink and results are included. Both the proposed techniques are evaluated by experimentation on a scaled-down laboratory prototype of solar inverter, developed for the purpose.

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Title	***:***	***An Optimal Smoother Based Dynamic State Estimator for Power Systems Considering PMU Measurements***
Author(s)	***:***	***Sreenath J G***
Roll No	***:***	***13104056***
Supervisor(s)	***:***	***Chakrabarti Saikat***

Abstract:

State estimation of the electric power transmission network has become an integral part of any modern control centre around the world and it provides the best estimates of the system states. State estimators ensure the secure operation of a power system. The development of synchronized measurement technology (SMT) has opened new avenues for the dynamic monitoring of the system states. This study introduces a power system state estimator based on a two pass algorithm known as the Rauch-Tung-Striebel (RTS) smoother. The RTS smoother is a two pass algorithm consisting of a standard Extended Kalman Filter (EKF) based forward pass and a backward recursion smoother. The state estimator incorporates conventional Supervisory Control and Data Acquisition (SCADA), as well as Phasor Measurement Unit (PMU) measurements and the system states are estimated when measurements are obtained from SCADA and/or PMU. The complex current measurements obtained from the PMU are directly incorporated into the state estimator. A dynamic model of the system is developed considering the system to be in a quasi-static state. The unknown parameters of the power system dynamic model are identified using Holt's 2- parameter linear exponential smoothing technique. The results show that the RTS smoother can improve the estimation accuracy. The IEEE 14, 30, and 118-bus systems are taken as the test bed for the study. The proposed DSE is validated under the real-time environment using Real Time Digital Simulator (RTDS), a real-time simulation tool, to assess its effectiveness for online visualization of the power system.

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Title	***:***	***Tunnel FETs and Its Application to Digital Circuits***
Author(s)	***:***	***Kumar Deepak***
Roll No	***:***	***13104037***
Supervisor(s)	***:***	***Mishra Santanu Kumar***

Abstract:

In advanced technology, the down-scaling of conventional MOSFETs has led to an impending power crisis, in which static power consumption is becoming too high. In order to improve the energy-efficiency of electronic circuits, small swing switches are interesting candidates to replace or complement the MOSFETs used today. Tunnel FETs, which are gated P-I-N diodes whose on-current arises from band-to-band tunneling between source and channel. These new devices can be attractive for low-power applications due to their low off-current and their potential for a small sub-threshold swing. This thesis studies some TFET based digital circuits and their performances. Since analytical models for Tunnel FETs are not available so the best way for circuit simulations is to build a Look up table based model using Verilog-A. Both the N and P type Tunnel FETs devices are simulated in Sentaurus 2D to generated look up table. This model is used to simulate static and dynamic behavior of Tunnel FET based digital circuits in cadence spectre.

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Title	:	*Power Sharing in Low Voltage DC Microgrid Using Low Speed Communication*
Author(s)	:	*Agarwal Shyam*
Roll No	:	*13104140*
Supervisor(s)	:	*Anand Sandeep*

Abstract:

Renewable energy resources are gaining popularity due to depleting fossil fuel and increasing energy demand. Microgrid allows efficient and reliable utilization of these renewable sources in both grid connected and standalone operations. Due to increasing use of dc sources and loads, low voltage dc microgrid is gaining popularity. To control the operation of dc microgrid centralize schemes are suggested in literature, which uses central controller with high speed communication. Presence of central controller limits the reliability of the system. Voltage-current droop controller based distributed control scheme is used for power sharing between sources. However, due to interconnecting cable impedance, trade-o_ exists between power sharing and voltage regulation. To address this limitation a dynamic droop gain adjustment technique is proposed in this thesis. This technique uses decentralized controller with low bandwidth communication to achieve equal power sharing and good voltage regulation. The source current of each converter is measured at low sampling rate and communicated to all other converters using Controller Area Network (CAN) communication technique. The communicated values of converter currents are used to adjust the droop gain in a decentralized manner, thereby improving the power sharing among converters. Key advantages of the proposed technique are equal power sharing, low voltage regulation and high reliability. Detailed small signal model of the proposed controller is developed. Delay due to sampling rate and communication is modeled. The stability of the system is analyzed by determining the eigenvalues. Sensitivity of eigenvalues to communication delay is observed with the help of root locus plots. Performance of the proposed method is verified by detailed simulation and experimentation studies. Eigenvalues to communication delay is observed with the help of root locus plot.

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Title	***:***	***Zero Net Energy House Cluster: Protection and Energy Management***
Author(s)	***:***	***Pandey Gaurav***
Roll No	***:***	***13104047***
Supervisor(s)	***:***	***Singh Sri Niwas***

Abstract:

The main objective of the present work is to create a smart dc micro-grid capable of 100% autonomous zero net electric energy in the cluster of buildings to facilitate a low-carbon sustainable electricity supply system under considerations of urban and rural scenarios. The propose model comprises of house clusters with an autonomous communication developed for the residential area, taking the consideration of stochastic behaviour of wind and solar irradiation. Voltage droop and Slope compensation peak current mode control technique for the bidirectional converters is employed for the Energy Storage System (ESSs). The bidirectional converter stage for house clusters plays a pivotal role in standalone operation, in case a battery pack is laid off from any house cluster, the dc bus voltage still be stabilized due to the proximity bidirectional converter stages of other house clusters or community bank. The houses in the cluster comprises of Permanent Magnet Synchronous Generator (PMSG), Solar Photovoltaic (SPV), battery bank and variable load. The dc protection schemes broadly classified as the unit and non-unit protection schemes under fault conditions is also investigated. The proposed model is simulated on MATLAB/ Simulink environment.

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Title	***:***	***Development of Control Strategies for Power Management with Renewable Resources***
Author(s)	***:***	***Jha Rahul Ranjan***
Roll No	***:***	***13104111***
Supervisor(s)	***:***	***Srivastava S C***

Abstract:

Renewable Energy Sources (RESs) are being increasingly deployed in the electrical networks, to address the growing environmental concerns and to ensure energy security. Amongst various types of renewable sources, Solar Photo Voltaic (SPV) and the Wind Turbine (WT) plants are the most promising. Output of these sources is intermittent in nature and, hence, energy storage devices are required to store surplus energy and feed to the load when needed. Proper operation of these sources to ensure voltage control and power management requires use of suitable converters. For the integration of the SPV to the utility grid, 3-phase Voltage Source Converter (VSC) has been used to convert DC into AC. Three types of controllers, viz. PID, Fuzzy Logic Control (FLC) and Adaptive Network based Fuzzy Inference System (ANFIS) have been implemented for the DC link voltage control and the VSC current control. The model of the Doubly Fed Induction Generator (DFIG), used for the wind plant, in the dq reference frame, and the control of the rotor side as well as the stator side converters are developed in this thesis. Battery Energy Storage System (BESS) is used, and integrated with the SPV and the wind turbine, connected to the utility grid. A bidirectional three phase VSC is used for charging and discharging of the battery. To develop controls for the home PV systems, a cluster of four houses has been considered, in which each house comprises of a SPV and a battery. The power requirement of the load is met either by the SPV or the battery. The power management among the houses is ensured by the proposed controllers in the islanded mode.

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Title	***:***	***Object Matching Based on Speeded Up Robust Features***
Author(s)	***:***	***Annepu Y V Harsha Vardhan***
Roll No	***:***	***Y9329105***
Supervisor(s)	***:***	***Verma Nishchal Kumar***

Abstract:

Autonomous object counting system is of great use in retail stores, industries and also in research processes. A Speeded Up Robust Feature (SURF) based robust algorithm for identifying, counting and locating all instances of a defined object in any image, has been proposed. The defined object is referred to as prototype and the image in which one wishes to count the prototype is referred to as scene image. The algorithm starts by detecting the interest points for SURF in both, prototype and scene images. The SURF points on prototype are first clustered using density based clustering; then SURF points in each cluster are matched with those in scene image. The SURF points in scene image that have been matched w.r.t. a single cluster, are clustered using the same clustering algorithm. Each cluster formed in scene image represents an instance of prototype object in the image. Homography transforms are further used to give exact location and span of each prototype object in the scene image. Once the span of each prototype is defined, SURF points within this span are matched with the prototype image and then Homography transform is once again applied while considering the newly matched SURF points; thus eliminating noisy detection/s of prototype. While the same process is repeated with each cluster, a novel centroid based algorithm for merging repeated detections of same prototype instance is used. Carrying the benefits of SURF and Homography transforms, the algorithm is capable of detecting all prototype instances present in scene image, irrespective of their scale and orientation. The complete algorithm has also been integrated into a desktop application, which uses camera feed to report the real time count of the prototype in the scene image

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Title	:	*Rotor Angle Estimation and Coherency Detection of Synchronous Generators*
Author(s)	:	*Gudla Ajay Kumar*
Roll No	:	*13104049*
Supervisor(s)	:	*Chakrabarti Saikat*

Abstract:

Power system is the biggest, interconnected and complex system in the world. Since the demand for power is increasing day by day, synchronous generators are forced to operate near the stability limit. Hence, a fault or disturbance in system can cause the generators to step out of synchronism, which may cause instability of the entire system. It is very important to access stability of synchronous generators. In this thesis, we are concerned about angular stability only. To access that, rotor angle should be monitored in real time. Since the power system is big and interconnected, model reduction should be done for doing security analysis, transient stability analysis etc. Coherency is a popular concept, that can be used for model reduction. To identify coherent groups of generators, as a part of model reduction, we can use rotor angle of a generator as a basis. But, rotor angle is not measurable in the system. Hence, the proposed work develops a method to estimate the rotor angle in both transient and steady-state. With the advent of PMUs, we are able to estimate the rotor angle in real time. A PMU is placed at the generator bus and it measures bus voltage and branch current phasors. By using the PMU measurements and eld current from machine, the proposed algorithm estimates the rotor angle. In the present work, 7th order synchronous machine model is used. After distur- bance occurs, in sub-transient state, damper winding observer method estimates the rotor angle. In transient state, this method switches to Kalman lter method. The proposed algorithm is tested on several standard systems and implemented using hardware PMU interfaced with eMEGAsim real time digital simulator.

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Title	:	*Sliding Mode Control Strategies for Robotic Systems*
Author(s)	:	*Mitra Aritra*
Roll No	:	*13104019*
Supervisor(s)	:	*Behera Laxmidhar*

Abstract:

In this thesis, we investigate the feasibility of applying Sliding Mode Control (SMC), one of the best known robust control techniques, to two applications - Targeted drug delivery inside the human body using a fer- romagnetic micro-robot steered by a MRI, and Modeling and Control of a 4 Degree of Freedom (DOF) Barrett Whole Arm Manipulator (WAM). It is extremely difficult to obtain exact mathematical models of each of the systems under study, leading to unavoidable modeling errors. The problem statement for both the applications can be formulated as trajectory tracking problems of nonlinear dynamical systems with uncertainties. This motivates the use of SMC. First, we develop an Adaptive Fuzzy Sliding Mode Control (AFSMC) scheme for the MRI based drug delivery system, based on a highly nonlinear model available in literature. Simulation results illustrate that the proposed technique is able to reject disturbances, and achieve perfect tracking of the micro-robot along the centre line of a blood vessel. The 'chattering' phe- nomenon observed in conventional SMC is completely eliminated. Another significant merit of this framework, is its ability to estimate the dielectric density of blood on-line. Comparisons are drawn with a state-of-the-art backstepping approach. Next, we develop a rigid body model of a 4 DOF Barrett WAM using the recursive Newton-Euler technique. This is a major contribution as Bar- rett does not disclose its dynamic model. The precision achieved in rigorous trajectory tracking experiments performed in the joint space, validates the accuracy of the developed model. A variant of SMC, known as Nonsingular Fast Terminal SMC (NFTSMC), which guarantees fast finite-time conver- gence of the error trajectories to zero, has also been proposed for control of the WAM. We derive an analytical expression for the error settling time and demonstrate that the NFTSMC indeed guarantees faster performance as compared to a standard Nonsingular Terminal SMC (NTSMC). A detailed comparative study of simulation and experimental results is presented. Finally, aiming to integrate the robustness of SMC with optimal control theory, we integrate conventional SMC with Adaptive Dynamic Program- ming, to obtain a novel optimal sliding mode control framework. We present the general design procedure, stability analysis, and simulation results for both regulation and tracking problems, the latter being

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Title	***:***	***Vision Based Navigation of a Quadcopter using a single camera***
Author(s)	***:***	***Shree Atulya Shivam***
Roll No	***:***	***10327172***
Supervisor(s)	***:***	***Behera Laxmidhar***

Abstract:

Control of micro aerial vehicle is a major problem in indoor environments due to lack of reliable position sensors. While outdoor applications can use GPS for reliable localization, working indoors will require the use of Laser scanners or vision. If the indoor scene is not known to a robot the task of mapping new areas also becomes a necessity. The two processes are combined and run together in a framework of Simultaneous Localization and Mapping. Our work is focused on using cameras for the task of SLAM in an indoor environment. Vision based techniques though less accurate than Lasers have the potential of providing a low cost framework for navigation. Two techniques for obtaining position feedback have been used in this work 1] Localization using a known pattern in the scene and 2] Localization using a monocular SLAM framework on an unknown and unstructured scene. For mapping the scene a probabilistic framework has been implemented which can provide a semi-dense depth map of the surroundings. Finally the localization algorithm has been implemented on a quadcopter and experiments on hovering and waypoint-following demonstrated in an indoor lab based environment.

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Title	:	*Voltage Stability monitoring using Lyapunov Exponent*
Author(s)	:	*Mukherjee Mriganka*
Roll No	:	*13104082*
Supervisor(s)	:	*Chakrabarti Saikat*

Abstract:

In modern power systems, maintaining stability is a big challenge for the operators. Voltage stability is a major stability problem encountered in modern power system. For a number of recent power system blackouts, voltage instability has been found to be the main cause. Based on the time frame of events, voltage stability problems can be classified into long-term and short-term. For short-term stability problems, the control actions are mostly automatic, without much scope for operator intervention. For long-term stability problems, usually, the operator gets sufficient time to take preventive actions.The present work investigates the feasibility of using Lyapunov exponents for early detection of any impending voltage stability problem. It is well known that, near the point of voltage instability, the bus voltages may exhibit a chaotic behavior. A number of indices proposed in the literature are based on the fact that, near the point of voltage collapse, the system may go through a bifurcation. Lyuapunov exponent is a widely used index to identify the chaotic behavior of a dynamic system. In this thesis, a thorough investigation is done on the feasibility of using Lyapunov exponent for early detection of voltage stability problems. Phasor measurement units (PMUs) are increasingly being deployed in modern power systems. The main advantages of PMUs compared to conventional measurements are their higher accuracy, higher reporting rates, and time-synchronization capability. The present work explores the feasibility of using PMU measurements for monitoring short-term and long-term voltage stability problems in power systems

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Title	***:***	***Power Quality Improvement and Power Capacity Enhancement of Power Plant for Rural Telecom Applications***
Author(s)	***:***	***Maji Abhishek***
Roll No	***:***	***13104004***
Supervisor(s)	***:***	***Mishra Santanu Kumar&Joshi Avinash***

Abstract:

This thesis describes a complete power plant architecture for rural telecom exchanges where grid power is unreliable. The power plant is designed to work with one, two, or three phase input in a seamless manner without any de-rating of the output power. The operational input of the converter is between 90 V (rms) during single phase to 480 V (rms) during three phases. In order to enforce unidirectional power flow and seamless phase selection operation, a four-leg diode bridge is proposed for the input stage. The use of a four leg diode bridge to enforce automatic phase selection in three phase power application is a challenge because the output of the diode bridge has a wide voltage variation. In order to clip this voltage variation within an acceptable limit, a clamp-enabled converter follows this bridge. The clamp-enabled converter can be either step-up or step-down type depending on the input operational voltage range. The output of the clamp-enabled converter is cascaded to a conventional isolated step-down converter. In this paper, a full-bridge converter with current doubler is used. Passive power factor improvement techniques are used to improve the power factor during three-phase, two-phase, and single-phase operation. The proposed system is verified using a 1 kW prototype. Average current mode control technique is adopted for the proposed power plant to obtain regulated voltage at the output. To increase the current sourcing capability of the entire system and simultaneously reduce the switch stress, multi module paralleling is performed. Single wire autonomous current-sharing paralleling technique is employed for current-mode-controlled dc power modules. The proposed control circuit is designed by the three-loop control method. A design example of two 400 V/ 48 V, 25 A parallel modules is set up and experimental recordings verify the performance of current sharing.

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Title : *Modeling, Analysis, and Implementation of a Hybrid MOC for Solar PV Applications*

Author(s) : *Jamal Ishrat*

Roll No : *13104055*

Supervisor(s) : *Mishra Santanu Kumar*

Abstract:

Converters having high conversion ratio are preferred in renewable applications because they allow use of smaller solar panels to achieve higher output voltage. This leads to better performance of a solar-PV system as the power extraction is less susceptible to partial shading. A Current-Fed Switched Inverter (CFSI) has a very high conversion ratio of the order of 8-10, under practical scenario. The CFSI is hybrid Multi Output Converter (MOC), i.e., it is capable of producing AC and DC outputs, simultaneously, from a single input DC source. All these properties make it an excellent candidate for solar-PV applications in residential renewable systems. In this thesis, modeling, control, and usage of CFSI in a renewable nanogrid is presented. The steady-state and dynamic model of the converter are studied in detail. Conventional circuit averaging technique and energy conservation technique are used to derive these models. The AC/DC control-to-output response, output impedance characteristics, and audio susceptibility are derived. A lab prototype is designed to verify the models. The results are verified using PSPICE simulations and experimentally using a Frequency Response Analyzer (FRA). The output DC link of a CFSI is regulated using analog as well as digital controllers. The theory of controller implementation is derived and verified using conventional Bode plot method. The robustness of the feedback design is tested by testing the converter response to a step change in load and reference voltage. A soft-start technique for CFSI is discussed and implemented in digital domain. The application of a CFSI to a residential renewable nanogrid is verified using a lab scale prototype. The CFSI is designed to track Maximum power point (MPP) with a battery or a resistive load at the DC link. MPP is verified using three methods, (a) P & O method with a fixed DC link voltage, (b) P & O method with resistive load at the DC link, and (c) Input voltage control. In all the three methods, the MPP is tracked properly and maximum power from solar-PV is transferred to the load. The merits and de-merits of all the three methods are discussed.

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Title	***:***	***Design and analysis of ultra-lift LUO converter based PFC circuits***
Author(s)	***:***	***Srinivas Vanaparthi Venkata***
Roll No	***:***	***13104153***
Supervisor(s)	***:***	***Mishra Santanu Kumar***

Abstract:

This thesis studies the feasibility of using a higher order converter with high gain to implement a power factor correction rectifier. Ultra-lift Luo converter is a good choice for this application as it offers very high gain at lower duty cycles compared to conventional converters, e.g., boost converter. Based on Ultra-lift Luo converter, two new PFC (power factor corrected) circuits are proposed and analyzed. The first PFC circuit using this higher order converter is a bridge-less topology. It has unidirectional power flow capability. The proposed circuit uses two less passive components (one inductor and one capacitor) compared to the state of the art found in literature. The circuit is operated in DCM. The proposed circuit is validated using PSPICE simulation. The second PFC circuit is obtained by replacing the converter at the output of a diode bridge rectifier (in conventional PFC network) with an Ultra-lift Luo converter. Current sensing is avoided by operating the converter under DCM. Steady state and small signal models of the network are derived and voltage feedback regulation is implemented. The open loop operation of this proposed PFC network is validated by using an experimental prototype.

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Title : *Series Active Filter for Rectifier DC Link Current*
Author(s) : *Pakhira Ambar*
Roll No : *13104012*
Supervisor(s) : *Sensarma Partha Sarathi*

Abstract:

High power rectification (AC to DC) applications are invariably beset with problems of low-order even harmonic components in the rectified output variable. For applications which require a current input, e.g. HVDC converters, current source inverters, traction front-ends etc., attenuation of these harmonics are of utmost importance. Thus, in order to realize a current stiff DC link, the filtering requirement is stringent. Usually, to avoid increase in system complexity, an inductive filter is used, but there is a consequent reduction in efficiency and power density. To improve both these critical operating metrics (efficiency, power density) this thesis focuses on a series active filter scheme to provide additional attenuation, over and above the passive inductive filtering. This brings about a large reduction in the overall filter size, with a possibility of increase in efficiency. As per analytical investigations and numerical simulation, the inductance of a standard inductive filter could be reduced by a factor of 10, without even slightly affecting the low-order harmonics in the rectifier output current. The proposed active filter senses the rectifier output voltage and extracts the low order (even) harmonic components from the sensed voltage using a digital filter. It then injects a voltage in series with the inductor in order to ensure negligible low order harmonics in the voltage appearing across the inductor. Thus a stiff D.C. current link can be achieved with a smaller inductor. The control mechanism consisting of a single loop was implemented using FPGA. Simulation results show negligible lower order ripple in the D.C. link current. A lab prototype series active filter for a 700 VA rectifier was built using power MOSFETs as switches. The switching frequency was selected to be 10 kHz for low switching loss while not sacrificing control speed to a greater extent. Input to the rectifier was single phase 50 Hz 110V AC. This lab prototype was used to validate the analytical and simulation results.

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Title	***:***	***Design and Development of Single Phase Dynamic Voltage Restorer***
Author(s)	***:***	***Meena Amit Kumar***
Roll No	***:***	***13104013***
Supervisor(s)	***:***	***Anand Sandeep***

Abstract:

Dynamic Voltage Restorer (DVR) is a custom power device used in electrical distribution system for power quality improvement. The main application of DVR is for voltage compensation of sensitive loads against voltage disturbances like voltage sag and voltage swell in distribution lines. It is a series connected device and is able to compensate voltage sag and voltage swell by injecting a voltage with help of series transformer. The injection of an appropriate voltage component in the event of a voltage disturbance requires a certain amount of real and reactive power. Conventionally DVR consists of an energy storage device which supplies the required power over the limited duration of the sags. Large and long duration sags lead to heavy financial investment in energy storage unit. To overcome this limitation, a single phase back-to-back converter based DVR is implement in this thesis,which eliminates energy storage requirement. Two converters are connected through common dc link. In the event of voltage sag, front-end converter acts as active rectifier and other converter acts as inverter, injecting the voltage in series with grid voltage. Real power flows from rectifier to inverter. In case of voltage swell condition, the operation of two converters interchanged and energy is fed back to the source side converter from the load side converter. Modelling of both converters is done to determine the behavior of the system. For unity power factor operation of front-end converter, Phase Locked Loop is used which track the grid frequency and phase. Both converters are operated in closed loop. Front-end converter maintains the dc-link voltage and current drawn by DVR to unity power factor. Other converter maintains the injected ac voltage to the desired value. The DVR is designed for 5kVA load and source voltage in the range of 185V to 265V. DVR along with designed controllers are tested by simulation on MATLAB/Simulink. To validate the performance of the DVR, a laboratory prototype of 5KVA is developed. Control algorithms are implemented in TI make DSP TMS320F2808.The prototype is tested on both linear and non-linear loads.Performance of the prototype is also validated for step change in load.The results obtained from simulation approach and hardware are found to be in agreement. Various protection schemes such as, protection against under-voltage, over-voltage and overloading are implemented in the developed prototype.

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Title	:	*Study of Silicone Rubber based Composites with Nano- sized Fillers*
Author(s)	:	*Kumar Rakesh*
Roll No	:	*10327580*
Supervisor(s)	:	*Gupta Nandini*

Abstract:

Silicone rubber (SR) has emerged as a material of choice for housings in outdoor insulation in high voltage transmission. The surface hydrophobicity of SR based insulators makes them ideal for use as outdoor insulation especially in polluted environments. Research in nanodielectrics in the last decade has shown that addition of nanosized fillers into bulk polymers often improve their electrical and non-electrical properties significantly. Such properties include permittivity, breakdown strength mechanical strength, etc. In this work, we study the effect of incorporating barium titanate nanofillers into room temperature vulcanized silicone rubber (RTVSR). Nano-sized barium titanate (BaTiO3) particles are used as fillers in the RTVSR matrix with volume fractions of 0.5%, 1%, and 2%. While preparing samples, mechanical mixing and ultrasonic mixing is used to reduce the agglomeration of nano fillers. Scanning Electron Microscope (SEM) micrographs are used to thoroughly examine the dispersion of the nanofillers in the base matrix. The findings are also evaluated against silicone rubber composites filled with alumina instead of barium titanate. One of the most important issues in outdoor insulation is tracking specially in a polluted environment. Surface contamination of the insulator, and the consequent leakage currents, can cause operational problems in electric power utilities. Tracking on the surface of the insulator leads to degradation and even complete failure of the insulator over time. In this work, we study the effect of incorporation of nano-fillers on the propensity of the RTVSR to tracking and associated degradation. Inclined Plane Test (IPT) for erosion as per the IEC60587 is performed. Additionally, surface degradation tests are performed to estimate how the addition of nano fillers increases the resistance to degradation due to surface discharges.

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Title : *Design, Simulation and Development of a Multifunctional Active Power Filter for Power Distribution System*

Author(s) : *Kaka Bharadwaj*

Roll No : *13104028*

Supervisor(s) : *Das Shyama Prasad*

Abstract:

With increased penetration level of digital technology in power system, along with the growth of non-linear and power electronic loads, the current drawn from the grid is becoming far from sinusoidal. The non-sinusoidal currents drawn electrically pollute the power system resulting in poor power quality in addition to increased losses and stress in the transformers, lines and equipment. Furthermore, there are problems of voltage sag/swell and unbalancing in voltage/current. Thus there is a need to have a power quality conditioner/active power filter at appropriate voltage level to compensate for load current harmonics as well as voltage sag/swell and voltage unbalance. If necessary, the active power filter can also be additionally designed to compensate for load reactive power requirement. The present project aims at an integrated design, simulation and development of an active power filter for 415V systems. The topology for load current compensation & voltage sag/swell mitigation is simulated with non-linear, unbalanced and induction motor loads. Subsequently, a three phase 415V active power filter (prototype) is developed in the laboratory. The proposed active filter enables • Compensation of load current harmonics • Compensation of load reactive power • Compensation of unbalance in PCC voltages and load currents • Compensation of balanced/unbalanced voltage sag/swell and voltage flicker

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Title : *Design and Modelling of VSC-HVDC Transmission System Having Wind Farm*

Author(s) : *Roy Nirjhar*

Roll No : *13104093*

Supervisor(s) : *Singh Sri Niwas*

Abstract:

Over the last few years, installation of Voltage Source Converter based High Voltage Direct Current (VSC-HVDC) transmission systems have been increased considerably; due to lesser space requirements, better power quality, reactive power controllability, etc. Several control methods are available, though only a few are practically viable for grid integration. The work presented in this thesis investigates such a design method for the controllers of VSC-HVDC. The simulation results show that the designed controllers work well whether isolated from grid or integrated to grid. When connected with a wind farm and the grid, the outputs follow the grid codes for renewable energy generation. However, inclusion of fuzzy logic controllers (FLCs) improves the performances of the integrated system. A change in control method is proposed, where the FLCs are used in such a way that the complexity of the system reduces significantly and the performances improve. The advantages of the conventional controllers are still present, and merits of FLCs add on top of that as both controllers are used together in the control system. Further, the exploration with FLCs may be done to achieve better results for isolated or integrated power systems.

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Title	***:***	***DSP based Implementation of Induction Motor Control with Estimation of Rotor Time Constant***
Author(s)	***:***	***Kandlagunta Rahul Chowdary***
Roll No	***:***	***13104064***
Supervisor(s)	***:***	***Das Shyama Prasad***

Abstract:

Induction Motor is made to operate as variable frequency drive with Scalar Control, Vector Control techniques etc. DC Motor characteristics are replicated in Induction Motor using Vector Control technique. Vector Control gives good dynamic performance characteristics as flux and torque component currents are decoupled. In this thesis, Indirect Vector Control with rotor flux oriented synchronous reference frame is chosen. The slip speed required for synchronous speed calculation depends on the rotor time constant. Rotor Time Constant varies with temperature and this variation is estimated for proper rotor flux orientation. Rotor Time constant is estimated using Reactive Power Model Reference Adaptive Scheme. Simulation analysis is carried out in MATLAB SIMULINK to evaluate the performance of control schemes. A Lab prototype has been developed for the experimental verification. Controllers are implemented in TMS320F28335 DSP experimental kit. Hardware results are presented and they are compared with the simulation results with good agreement.

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